PROJECT SPECIFICATIONS

FOR

Greater Dayton Regional Transit Authority

Paratransit Bus Garage

701 Longworth Street
Dayton, Ohio 45402

BID SET

April 28, 2025

CA Project No. 634-7310-00

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SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 01: Fall Arrest System Assembly for Bus Garage Roof.

1. Base Bid: No Fall Arrest System.
2. Alternate: Provide Fall Arrest System Assembly for Bus Garage Roof as indicated on Drawings and as specified in Section 112424 "Fall Protection System."

B. Alternate No. 02: Lightning Protection System for Bus Garage Roof and Bus Wash Roof.

1. Base Bid: No Lightning Protection Systems.
2. Alternate: Provide Lightning Protection System as specified in Section 264100A "Facility Lightning Protection System – New or Stand-Alone Building."

C. Alternate No. 03: Drains in Bus Garage.

1. Base Bid: Linear drains in Bus Garage as indicated on Plumbing Drawings.
2. Alternate: Area drains in Bus Garage as indicated on Plumbing Drawings.

D. Alternate No. 04: RTA Branding Sign at southwest corner of the Bus Garage.

1. Base Bid: No Branding Sign.
2. Alternate: Provide RTA Branding Sign at southwest corner of Bus Garage as indicated on the Drawings and as specified in Section 101419 “Dimensional Letter Signage.” Replace GL-41 glass behind signage with MWP-1 panels. Add capped horizontal mullions above and below MWP-1 panels. Add cold form framing and sign blocking material within parapet wall for signage support.

END OF SECTION 012300

SECTION 014533 - SPECIAL INSPECTIONS AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for quality assurance and quality control.
   2. Special inspections and testing services required by the project contract documents and in accordance with the Ohio Building Code.

B. Related Requirements:
   1. Refer to individual technical specification section, Schedule of Special Inspections included in the Drawings, and Statement of Special Inspections for additional qualifications, inspections, tests, frequency and standards required.

C. Intent:
   1. For compliance with the Ohio Building Code, the Owner shall employ and pay for a special inspector (or inspectors) as required by Chapter 17 of the Ohio Building Code.
   2. Duties and responsibilities of the special inspector(s) shall be as outlined in Chapter 17 of the Building Code and as herein specified.
   3. Define and coordinate structural tests and special inspection services.
   4. Define and coordinate conventional testing and inspection services.
   5. Testing and Inspection services are intended to assist in determining probable compliance of the work with requirements specified.

D. Conditions:
   1. If inspection of fabricator’s work is required, the Authority Having Jurisdiction and/or Owner’s representative may require testing and inspection of the work at the plant, before shipment. Owner, Architect and Structural Engineer of Record reserve the right to reject material not complying with Contract Documents.
   2. Perform testing and inspection in accordance with industry standard used as reference for specific material or procedure unless other criteria are specified. In the absence of an industry standard, accomplish tests in accordance with generally accepted industry standards after review and approval of such testing by the Owner, Architect, and Structural Engineer of Record.
   3. Check the Work as it progresses. Failure to detect defective work or materials shall in no way prevent later rejection if defective work or materials are discovered, nor shall it obligate the Owner to accept such work.
   4. These services do not relieve the Contractor of responsibility for compliance with the requirements of the Contract Documents.

1.2 DEFINITIONS

A. Testing: Evaluation of systems, primarily requiring physical manipulation and analysis of materials, in accordance with approved standards.

B. Inspection: Evaluation of systems, primarily requiring observation and judgment.
   1. Continuous Inspection: The full-time observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.
   2. Periodic Inspection: The part-time or intermittent observation of work requiring special inspection by an approved special inspector who is present in the area where the work is being performed.

C. Structural Tests and Special Inspections: The Structural Tests and Special Inspection Services herein include those required by Chapter 17 of the Ohio Building Code and those that, in the professional judgment of the Owner, Architect, and Structural Engineer of Record, are critical to the integrity of the building structure.

D. Conventional Testing and Inspections: Conventional Testing and Inspection Services herein describe those items not specially required by Code but may be considered essential to the proper performance of the building systems.

E. Architect of Record: The prime consultant in charge of overall design and coordination of the Project.

F. Structural Engineer of Record (SEoR): The Licensed Engineer in responsible charge of the structural system(s) and component(s) comprising the main superstructure.

G. Licensed Structural Engineer; Specialty Engineer; Delegated Engineer: A professional engineer in good standing and active license in the State of Ohio with education and experience in the design of structures similar to this Project.

H. Testing Agency (TA):
   1. Testing Agency: Approved independent testing agency acceptable to the Owner, Architect, SEoR and as noted below:
      a. Authorized to operate in the State of Ohio and experienced with the requirements and testing methods specified in the Contract Documents.
      b. Meeting applicable requirements of references stated in paragraph 1.4.

I. Special Inspector (SI): A properly qualified individual or firm performing special inspections.

J. Authority Having Jurisdiction (AHJ): The organization, officer, or individual responsible for approving and enforcing the requirements of the Ohio Administrative Code.

K. Building Official: The Officer or duly authorized representative charged with the administration and enforcement of the Ohio Building Code.

L. Approved Agency: An established and accredited testing laboratory, listing agency, inspection body, or field evaluation body recognized by the Board of Building Standards providing services consistent with their accreditation and the code section requiring the approved agency service.

M. Approved Fabricator: An established and qualified person, firm or corporation approved in accordance with the rules of the Ohio Department of Commerce Board of Building Standards.

1.3 REFERENCES

A. ANSI/ASTM E329 – Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

B. ASTM E543 – Standard Practice for Agencies Performing Non-destructive Testing.

C. Ohio Building Code.

D. See technical specification sections for specific references.

1.4 RESPONSIBILITIES/AUTHORITY

A. Structural Tests and Special Inspections:
   1. Special Inspector:
      a. If requested, attend a preconstruction meeting to review the scope of Structural Testing and Special Inspection.

b. Test and/or inspect the work assigned for conformance with the building department approved plans, specifications, and applicable material and workmanship provisions of the code. Perform testing and inspection in a timely manner to avoid delay of work.
c. Bring nonconforming items to the immediate attention of the Contractor for correction, then, if uncorrected after a reasonable period of time, to the attention of the Structural Engineer of Record, the Building Official, and to the Architect of Record.
d. Submit test and/or inspection reports to the Building Official, Contractor, Architect, the Structural Engineer of Record, and other designated persons in accordance with the Structural Testing and Special Inspection Schedule.
e. Submit a final signed report stating whether the work requiring special inspection was, to the best of the inspector's knowledge, in conformance with the approved plans, specifications and the applicable workmanship provisions of the code.

2. Architect:
   a. Coordinate the flow of reports and related information to expedite resolution of construction issues.
3. Structural Engineer of Record:
   a. Identify items requiring structural testing and special inspection.
   b. Define "type" of special inspector required for "description" of work indicated on the Structural Testing and Special Inspection Schedule.
   c. Attend pertinent pre-installation meetings to review scope of structural testing and special inspection.
   d. Complete and sign the Structural Testing and Special Inspection Schedule in conjunction with other responsible parties prior to commencing construction.
   e. Review reports issued by all special inspectors.
   f. If engaged as a special inspector, provide structural testing and special inspection services as noted in Article 1.5.A.1.
4. Testing Agency:
   a. If requested, attend a preconstruction meeting to review the scope of Structural Testing and Special Inspection.
   b. When engaged as a special inspector, provide structural testing and special inspection services as noted herein.
5. Contractor:
   a. Arrange and attend all pre-installation meetings to review scope of structural testing and special inspection. Include the Building Official, Owner, Architect, SEoR, Testing Agency and other parties concerned.
   b. Post or make available the Structural Testing and Special Inspection Schedule within project site office. Provide timely notification to those parties designated on the schedule so they may properly prepare for and schedule their work.
   c. Provide special inspector access to the approved plans and specifications at the project site.
   d. Review all reports issued by special inspectors.
   e. Retain at the project site all reports submitted by the special inspectors for review by the building official upon request.
   f. Correct in a timely manner, deficiencies identified in inspection and/or testing reports.
   g. Provide safe access to the work requiring inspection and/or testing.
   h. Provide labor and facilities to provide access to the work and to obtain, handle and deliver samples, to facilitate testing and inspection and for storage and curing of test samples.
   i. Verification of conformance of work within specified tolerances is solely the responsibility of the Contractor.
6. Fabricator:
   a. Submit a Certificate of Compliance to the Building Official, Special Inspector, and Structural Engineer of Record stating the work was performed in accordance with the Contract Documents.
7. Building Official (typical duties noted for <u>information only</u>; coordinate with Building Official):

a. Review special inspector qualifications.
b. Review fabricators who perform work in their shop, which requires special inspection.
c. Accept and sign completed Statement of Special Inspections.
d. Determine work, which, in the Building Officials opinion, involves unusual hazards or conditions.
e. Review reports and recommendations submitted by special inspector.
f. Review the "final signed reports" submitted by special inspector. These documents must be accepted and approved by the building department prior to issuance of a Certificate of Occupancy.

8. Owner:
   a. Establish direct funding to provide for cost of structural testing and special inspection services.
   b. Provide special inspector with Contract Documents and reviewed shop drawings.
   c. Provide special inspectors and testing agencies with full access to the site at all times.
   d. Review the Special Inspection Schedule(s) in conjunction with other responsible parties prior to commencing construction.

B. Conventional Testing and Inspection:
   1. Testing Agency:
      a. Test or inspect the work assigned, for conformance with building department approved plans, specifications and applicable workmanship provisions of the OBC.
      b. Bring nonconforming items to the immediate attention of the Contractor, and if uncorrected to the Architect of Record.
      c. Submit test and/or inspection reports to the Architect of Record, the Contractor and other designated persons.
   2. Contractor:
      a. Provide adequate notification to testing agency so they may properly prepare for and schedule their work.
      b. Provide testing agency with access to the approved design drawings, approved shop drawings and specifications at the Project site.
      c. Correct in a timely manner, deficiencies identified in test and/or inspection reports.
      d. Provide testing agency with safe access to the work requiring testing and inspection.
      e. Provide labor and facilities to provide access to the work and to obtain and handle samples, to facilitate testing and inspection, and for storage and curing of test samples.
      f. Verification of conformance of the work within specified construction tolerances is solely the Contractor's responsibility.
   3. Architect of Record (or other Prime Consultant):
      a. Coordinate the flow of reporting and related information to expedite resolution of construction issues.

C. Contractor's Responsibility to the Building Official:
   1. Contractor shall provide adequate notice for inspections performed by the building official, as required by the Ohio Building Code and local ordinance.

D. Periodic Site Observations by Design Consultant:
   1. Special structural testing and inspection, conventional testing and inspection, and periodic inspections by the building official do not preclude the normal field involvement and site observations by the Architect or Structural Engineer of Record, nor shall they relieve the Contractor of any responsibility to complete the work in accordance with the Contract Documents.

E. Limits of Authority:

1. Testing agents and/or special inspectors may not waive or alter Contract requirements, or approve or accept any portion of the Work unless specifically authorized by the Architect or Structural Engineer of Record. They may not assume any duties of the Contractor, any they have no authority to stop or reject Work.

1.5 PAYMENT

A. Owner shall directly employ and pay for services of the special inspectors to perform required Structural Testing and Special Inspection.

B. Owner shall employ and pay for services of the testing agency to perform required Conventional Testing and Inspection.

C. Unless noted otherwise, the Contractor shall provide and pay for all materials, samples, mock-ups, and assemblies required for testing and inspection and shall pay for all shipping costs related to delivery of this work. Testing agency will pay for shipping costs of samples transported from site to lab.

D. If exploratory work is required to determine the cause of defects, the cost of such work shall be paid by the Contractor, if the work is found to be defective, in the judgement of the Architect/Engineer. Contractor shall reimburse the Owner for all costs incurred in this event.

E. Any tests required to qualify the Contractor, or the Contractor's employees for any phase of the Work, shall be performed at no additional cost to the Owner.

1.6 INSPECTION NOTICES

A. Contractor: Provide a minimum of 24 hours' notice for all items requiring testing or inspection. Do not place items requiring testing and inspection services prior to or during placement until testing and inspection services are available. Do not enclose or obscure items requiring testing and inspection services after placement until testing and inspection services are performed.

1.7 REPORTS

A. Testing agency and/or special inspectors shall submit a report in accordance with the Structural Testing and Special Inspection Schedule and shall conduct and interpret tests and inspections and state in each report whether; (1) test specimens and observations comply with Contract Documents, and specifically state any deviations, (2) record types and locations of defects found in work, (3) record work required and performed, to correct deficiencies.

B. Submit reports for structural testing and special inspection, in timely manner to the Contractor, Building Official, SEoR, and Architect.
   1. Submit reports for ongoing work, to provide the information noted below:
      a. Date issued.
      b. Project title and number.
      c. Firm name and address.
      d. Name and signature of tester or inspector.
      e. Date and time of sampling.
      f. Date of test or inspection.
      g. Identification of product and specification section.
      h. Location in project, including elevations, grid location and detail.
      i. Type of test or inspections.
      j. Results of tests or inspections and interpretation of same.
      k. Observations regarding compliance with Contract Documents or deviations therefrom.
   2. Submit final signed report stating that, to the best of the special inspector’s knowledge, the work requiring testing and/or inspection conformed to the Contract Documents.

1.8 FREQUENCY OF TESTING AND INSPECTION

A. For detailed requirements see individual technical specification sections, and Part 3 of this section.

1.9 PROTECTION AND REPAIR

A. Upon completion of testing, sample-taking, or inspection, repair damaged work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed surfaces, as judged solely by the Architect/Engineer of Record. Protect work exposed by or for testing and/or inspection and protect repaired work. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for testing and/or inspection.

1.10 TESTS TO DEMONSTRATE QUALIFICATION

A. If the Contractor proposes a product material, method, or other system that has not been pre-qualified, the Architect or SEoR may require applicable tests, to establish a basis for acceptance or rejection. These tests will be paid for by the Contractor.

B. The Architect or SEoR reserves the right to require certification or other proof that the system proposed, is in compliance with any tests, criteria or standards called for. The certificate shall be signed by a representative of an independent testing agency.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCOPE OF STRUCTURAL TESTING AND SPECIAL INSPECTION SUMMARY

A. Refer to individual specification articles and Schedule of Special Inspections shown in the Drawings for scope of structural testing and special inspection.

B. The parties involved shall follow and complete the Special Inspection Schedule(s). The completed schedule of required inspections is an element of the Contract Documents and, after permit issuance, becomes part of the building department-approved plans and specifications.

END OF SECTION 014533

01 91 00 COMMISSIONING

PART 1 - GENERAL

1.1 Summary

A. This project is to be commissioned. The commissioning process, which the Commissioning Team including all Contractors is responsible to execute, is defined herein and in related sections. The commissioning process will be directed by the Commissioning Authority (CxA) with participation from of all Contractors.

B. This section includes requirements for commissioning that are defined in the particular specification sections, including the following:

1. Each Contractor shall participate in the Building Commissioning process, as prescribed in the Contract Documents.
2. Each Contractor shall participate in commissioning meetings.
3. Each Contractor shall Review Owner's Commissioning Plan, Basis of Design (BoD) documentation.
4. Each Contractor shall complete Construction Checklists and Functional Performance Testing Procedures using CxA standard forms provided by the CxA and/or using the online database with permission granted from CxA. Initial sample of forms are provided as part of this project manual; electronic copy of forms will be available per request of the Architect/Engineer (AE)/Construction Manager using the commissioning documentation data base.
5. The Contractor shall permit the A/E or the Commissioning Agent (CxA) access to commission performance-based equipment, and/or systems prior to final acceptance or partial occupancy if applicable.
6. Each Contractor shall participate in the performance of functional performance tests as specified herein and in related sections.
7. The A/E or the CxA shall promptly notify, in writing, the Contractor responsible for the fixture, equipment and/or system, of any deficiency.
8. During testing, if issues are identified that result in needed corrections by the Contractor and the testing to be re-scheduled, the Contractor shall pay all reasonable costs of CxA, separate Contractors, the Owner, and the Contracting Authority for delay, interference, hindrance or disruption of the Project due to Contractor without fault of the A/E, Separate Contractors, the Owner or the Contracting Authority. The Contractor shall pay the CxA for retest costs.

C. Description and Application of Commissioning on This Project:

1. Commissioning is a validation process to document that a particular product, assembly, system, process, or facility meets and will continue to meet predetermined requirements and criteria.
2. Commissioning will be applied on this project to specific systems and components of the building as stipulated in this section and in the product specifications, and will be based on the requirements documented in the BoD and construction documents prepared by the A/E.
3. The commissioning process does not take away from or reduce the responsibility of the system designers or installing Contractors/Sub-Contractors to provide a finished and fully functioning product.

D. The overall goal of the commissioning process is to verify that the completed project was designed and constructed to meet the requirements of the Owner and user of the project. Commissioning during the construction phase is intended to achieve the following objectives:

1. Ensure applicable equipment and systems are installed properly, receive adequate operational checkout and start up by installing contractors.
2. Ensure that installed equipment and systems meet owner's design and operational requirements.
3. Verify and document proper installation and performance of equipment and systems.
4. Ensure that Operation and Maintenance (O&M) documentation submitted by the contractors to the CM for inclusion in the Systems Manual is complete.
5. Ensure owner's operating personnel are adequately trained.

E. All CxA documentation shall be published, managed, and recorded using an online database controlled by the CxA. The Contractor shall participate and manage their specific commissioning related documentation using this software.

1.2 Definitions

A. Acceptable Performance: Complying with requirements and satisfying the Owner's Project Requirements and Basis of Design documentation.

B. Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review.

C. Architect / Engineer (A/E): The prime consultant and sub-consultants who comprise the design team, generally the mechanical designer/engineer and the electrical designer/engineer.

D. Basis of Design (BoD) Documents: Documents, prepared by the A/E, that record the foundation for calculations, decisions, schemes, and product selections; describe in detail the measurable performance requirements to achieve the Owner's program; and satisfy applicable regulatory requirements, standards, and guidelines.

E. Commissioning Authority (CxA): An agent, not otherwise responsible for the design or the construction. The CxA directs and coordinates the day-to-day commissioning activities. The CxA does not take an oversight role like the CM. The CxA is part of the commissioning team and shall report directly to the Owner.

F. Commissioning Plan: The document that outlines the organization and schedule of commissioning tasks and allocates resources for the performance and documentation of commissioning processes.

G. Commissioning Schedule: Written schedule for commissioning. This schedule is to be fully integrated into and accounted for in the overall project schedule by the Contractor(s).

H. Commissioning Team: Consists of Owner's Agent (OA), the CxA, all Contractors, and subcontractors who will perform testing.

I. Construction Check: The process of validating that the installation conditions of a system, subsystem, or component are appropriate to allow startup and functional performance testing to proceed.

J. Construction Checklist (CC) and Startup Checklist (SC): A list of items to inspect and component tests to conduct to verify proper installation of equipment, provided by the CxA to the Contractor/Sub-Contractor. Construction and startup checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation. However, some construction and startup checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a

three phase pump motor of a chiller system). Construction and startup checklists augment and are combined with the manufacturer's startup checklist.

K. Construction Checklists, Pre-Functional and Functional Performance Testing Procedures: Modified checklists and test procedures based on the CxA's standard forms for each system, subsystem, and equipment to be commissioned.

L. Deferred Functional Tests: FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

M. Functional Performance Completion: The date, certified by the Commissioning Team, when functional performance testing, including the associated documents and reports, has been completed.

N. Functional Performance Test (FT): The process of validating the ability of a system, subsystem, and BoD documentation in which the CxA team participates.

1. Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation.
2. Systems are tested under various modes, such as during high loads, component failures, unoccupied, varying outside air temperatures, fire alarm condition, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state.
3. The CxA develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing Contractors/Sub-Contractors or vendor. FTs are performed after construction and startup checklists, and startups are complete.
4. The Controls Installer provides access to the Controls Platform for all FTs.

O. Issues Log: The CxA shall prepare an on-going list of items requiring additional information, for non-compliance, for non-conformance, and design deficiencies. Team members are to work to resolve items and these are to be documented.

P. Owners Projects Requirements (OPR): Document detailing the functional requirements of the project and the building's use and operation as they relate to the systems to be commissioned.

Q. Pre-functional Testing: The process of validating the ability of a system, sub-system, or equipment to achieve the OPR & BOD prior to actual functional performance testing. This process is completed by the Contractor in order to demonstrate readiness for functional performance testing.

R. Systems Manual: The Systems Manual provided by the Construction Manager provides the information needed to understand, operate, and maintain the systems and assemblies within a building. It expands the scope of the traditional operating and maintenance documentation and is compiled of multiple documents developed during the commissioning process, such as the owner's project requirements, operation and maintenance manuals, and sequences of operation.

S. Warranty Period: Warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals. Equipment that does not initially pass seasonal or deferred functional testing shall have the warranty start date adjusted to date of passing test completion.

1.3 Responsibilities

A. The responsibilities of various parties in the commissioning process are provided in this section. The responsibilities of the Construction Manager (CM) and Contractor for specific systems, are in associated Division sections. The responsibilities of the (other) Contractors/Sub-Contractors are noted in their specification documents.

B. Mechanical and Electrical Designers/Engineers (A/E)

1. Perform normal submittal review, construction observation, as-built drawing preparation, records, etc., as contracted.
2. Provide design narrative and sequence documentation requested by the CxA. The designers shall assist (along with the Contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
3. Attend commissioning scoping meetings and other selected commissioning team meetings, as requested.
4. Review and approve Contractor system testing.
5. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
6. Review and approve the O&M manuals.
7. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning including warranty-period commissioning.

C. Commissioning Authority (CxA)

1. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management, means or methods. The CxA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the CM and the A/E.
2. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—which systems are functioning in accordance with the Contract Documents. The Contractors shall provide all tools or the use of tools to start, checkout and functionally test equipment and systems.
3. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
4. Coordinate the commissioning work and, with the CM, ensure that commissioning activities are being scheduled into the master schedule.
5. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
6. Request and review additional information required performing commissioning tasks, including O&M materials, Contractor startup and checkout procedures.
7. Before startup, gather and review the current control sequences and interlocks and work with Contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
8. Write and distribute construction and startup checklists.
9. Review factory startup plan and develop a startup plan and initial systems checkout plan with Contractors.
10. Perform site visits, as necessary, to observe component and system installations. Attends selected progress meetings and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
11. Review and approve construction and startup checklists completion in conjunction with selected site observation and spot checking.

12. Oversee sufficient startup and initial testing of the control system and verify it is ready to be used.
13. After submittals are approved, write the functional performance test procedures for equipment and systems. This may include control system trending, stand-alone data logger monitoring or manual functional testing.
14. Review contractor testing and reports before scheduling Functional Performance Tests.
15. Maintain a master deficiency and resolution log and a separate testing record. Provide the CM and OA with written progress reports and test results with recommended actions.
16. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
17. Compile and maintain a commissioning record.
18. Provide a final commissioning report (as described in this section).

D. Owner's Agent (OA)

1. Manage the contract of the A/E and of the CM.
2. Arrange the opportunity for facility operating and maintenance personnel to attend various field commissioning activities and field training.
3. Identify any possible warranty items, document and contact the Contractors/Sub-Contractors for follow-up.
4. Ensure that any seasonal or deferred testing and any deficiency issues are identified.

1.4 Submittals

A. Normal Submittals

1. The CxA will receive a copy of the normal submittals for equipment to be commissioned for their use.
2. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the CxA review.

B. Startup Plan: For each piece of equipment or system for which formal startup is specified in Sections of Divisions 02 through 28 and in this section. Include the following information:

1. Startup schedule dates.
2. Name of firms and individuals required to participate.
3. Detailed startup procedures.
4. Startup data and report forms.

C. Test Equipment Identification List: For each instrument, sorted according to intended use. Include the following information:

1. Manufacturer, model number, and serial number.
2. Calibration certification.
3. Range.
4. Accuracy.
5. Resolution.
6. Intended use.

D. Notice of Readiness: As each system, subsystem, and equipment becomes ready for functional performance testing, the contractor shall notify the Commissioning Team that the system is ready for functional testing and will demonstrate readiness by documenting the successful completion of pre-functional testing and construction checklists.

E. Certificate of Functional Completeness: Final acceptance procedures test check-off sheets, signed by the CxA and accompanied by the CxA's final report recommending functional completion and approved by the OA.

F. Qualification Data: For firms and persons part of each contractor's team.

1.5 Quality Assurance

A. Test Engineer Qualifications: Individual experienced in startup and troubleshooting for the systems and equipment specified to be commissioned.

B. Test Equipment Calibration Requirements: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damage. Affix calibration tags to test instruments. All instruments shall be within one (1) year of last calibration date.

1.6 Coordination

A. Commissioning Scope Meeting: All Contractors shall participate in a scope meeting with the Commissioning Team chaired by the CxA and scheduled by the OA. The purpose of the meeting includes a Commissioning Plan review with discussions of the commissioning schedules, construction check and functional performance test procedures, documentation requirements, and assignment of responsibilities.

B. Commissioning Coordination Meeting(s): All Contractors will meet on a pre-determined and approved basis by the CxA to review progress on the commissioning work, coordinate scheduling conflicts, and to discuss strategies and processes for upcoming commissioning tasks. The meeting(s) will be chaired by the CxA and will coincide with a regularly scheduled project progress meeting.

C. Schedule the witnessing of startup and test activities with the CxA. Each Contractor shall notify the OA and the CxA, in writing, at least 14 days before startup and testing activities and indicate data, time, location, and anticipated duration of activity. The OA or the CxA may delay procedures by not more than 48 hours.

D. The CxA shall inform contractor(s), before startup and functional performance testing begins, about the test procedures and the level of acceptable test results.

E. The OA will coordinate meetings and conferences according to Division 01 Section "Project Management and Coordination."

F. Contractor shall monitor, resolve, and respond to issues assigned them by the CxA via the Commissioning Issues Log via the Commissioning Documentation Management Database Referenced herein.

1.7 Prerequisites to Substantial Completion

A. All Test Adjust and Balance (TAB) work and commissioning must be complete prior to Functional Performance Testing and/or Final Acceptance of the building systems, unless approved in writing by the OA. Exceptions to this include; any required seasonal or approved deferred testing, and (10 month) Warranty Walk.

Items requiring completion for all systems include, but are not limited to:

1. Completed and signed startup, construction checklist, and pre-functional testing documentation.

2. Requested trend log data.
3. Submission of final approved TAB report **prior** to functional testing.
4. Completion of all functional testing.
5. CM's Submission of the approved Systems Manual.
6. All identified deficiencies and/or issues have been corrected or are approved by the OA to be accepted from the process.

B. The OA will determine the date of Final Acceptance after reviewing with the CxA status of issues and required final documentation.

1.8 Related Sections

A. 23 08 00 – Commissioning of HVAC Systems

B. 26 08 00 – Commissioning of Electrical Systems

PART 2 - PRODUCTS

2.1 Test Equipment

A. Furnish industry standard test equipment required for performing the specified tests. Obtain proprietary vendor specific test equipment from the vendor or manufacturer, including portable or hand-held setup and calibration devices required to initialize the control.

B. Contractor instruments shall meet the following standards:

1. Be of sufficient quality and accuracy to test and/or measure system performance within the tolerances required.
2. Be calibrated at the manufacturer's recommendation intervals with calibration tags permanently affixed to the instrument.
3. Be maintained in good repair and operating condition throughout the duration of use on this project.
4. Be immediately re-calibrated or repaired if dropped and/or damaged in any way during use on the project.

PART 3 - EXECUTION

3.1 Pre-functional Tests

A. Construction Check Inspections: As work progresses, the Contractor shall inspect systems, subsystems, and equipment to be commissioned to verify readiness for startup, TAB, and functional performance testing. After startup is conducted, Contractor shall verify equipment is operating, and all system parameters are appropriately set prior to TAB and performance of commissioning functional tests.

B. Startup and Initial Checkout: Once work is completed and the equipment/system is ready to operate, Contractor shall perform startup inspections/checks, and then conduct the startup procedures for systems and equipment. All pre-check and startup work shall be documented as part of the startup report.

C. Defective Work: Report defective Work to CxA for inclusion in the Issues Log. "Defective Work" is defined in the General Conditions of the Contract for Construction.

D. Readiness for Functional Performance Test: Contractor shall fully test and document that each system, subsystem, or equipment has been verified consistent with the stated requirements of functional performance testing and document successful completion.

3.2 Documentation

A. Commissioning Plan: The CxA and the OA have developed a preliminary Commissioning Plan that identifies the commissioning process and participants, consistent with the contract documents. The Contractor(s) will work with the Commissioning Team to determine how commissioning activities will be integrated into construction and trade activities. The plan shall include all members of the construction phase Commissioning Team and appropriate schedule items.

B. Commissioning Schedule: Assist in the development of a written schedule that integrates the commissioning activities into the construction schedule specified in Division 01 Section "Construction Progress Documentation." Update commissioning schedule during the progress of construction to reflect changes in the Work. Distribute copies of updated commissioning schedule activities to members of the Commissioning Team. The commissioning schedule shall include at least the following:

1. Submittal dates for construction checklists, startup procedures, functional testing forms, O&M manuals.
2. Schedule dates for systems and equipment startup (including services of manufacturers' authorized service representatives) and completion of construction checklists.
3. Schedule dates for TAB procedures and testing (including each phase if project has multiple phases).
4. Schedule dates for functional performance testing. Identify any seasonal testing required and anticipated dates.
5. Dates will be determined by the OA for the (10 month) Warranty Walk by Commissioning Team

C. Commissioning Meeting Minutes: The CxA shall prepare minutes of initial scope and progress conferences, and will include a copy of the agenda, and identify location and date of conference, and individuals in attendance. Minutes will be distributed to members of the Commissioning Team.

D. Startup Reports: Upon completion of startup of all equipment identified to be started-up, update and complete via the Commissioning Documentation Database of the completed startup documentation and associated construction checklist. All deficiencies shall be provided in writing to the CxA for inclusion in the Issues Log.

E. Construction Checklists & Pre-Functional Test Completion: In cooperation with manufacturers and installers, modify CxA standard checklist forms provided in other product specification sections in this project manual for use in inspecting systems, subsystems, and equipment before startup and pre-functional performance testing. Include identification of system, subsystem, or equipment, and identification of manufacturer and installer. Update and complete via the online Commissioning Documentation Database.

F. Notice of Readiness: Submitted by the Contractor to OA certifying that systems/equipment and associated controls are ready for functional performance testing.

G. Functional Performance Test Forms: Report results of systems, subsystems, and equipment functional performance tests. Prepare reports via the Commissioning Documentation Database on approved test forms and include identification of system, subsystem, or equipment, and identify date of test, manufacturer and installer.

H. O&M Manuals: Contractor shall prepare written text and/or special drawings to provide necessary information, where manufacturer’s standard printed data is not available and information is necessary for a proper understanding and operation and maintenance of equipment or systems, or where it is necessary to provide additional information to

supplement data included in the manual or contract documents. Upload this information in *.pdf format via the online Commissioning Documentation Database.

3.3 Functional Performance Testing

A. Test Procedures: Review and provide recommended edits/revisions to the Functional Test Forms provided as part of this project manual for use in conducting complete performance functional tests on systems/equipment to be commissioned. Functional Tests shall include detailed procedures for functional performance testing of systems, subsystems, and equipment.

1. Testing procedures shall verify and demonstrate the ability of systems, subsystems, and equipment to perform according to the BoD documentation and shall include the following:
   a. Operation of each system, subsystem, and equipment through all modes of operations (seasonal, occupied, unoccupied, warm-up, cool-down, and part and full load) where there is a specified system response.
   b. Verification of each sequence of operation.
   c. Verification of proper responses and planned modes and conditions, including normal and abnormal operating conditions and emergency operating conditions.
2. Develop test procedures from information provided in the following:
   a. Approved systems descriptions.
   b. Contract Documents.
   c. Submittals.
   d. Manufacturer's installation, startup, and inspection instructions.
   e. Control operational sequences, program code, control set points, and parameters.
   f. Each procedure shall have a unique designation.
3. Identify test engineer to perform test and their required qualifications.
4. The same procedure may be applied to multiple identical pieces of equipment or systems.
5. Procedures shall reference the applicable specification Section on which the procedure is based.
6. Identify acceptable performance.
7. Equipment may include integral safety devices to start or prevent equipment from operation unless minimum safety standards or conditions are met. Functional performance test procedures shall demonstrate the actual performance of safety shutoffs in real or closely simulated conditions of failure. Equipment and systems that include safety devices and components that control a variety of equipment operating as a system may have interlocks hardwired or installed via software to allow functional performance test procedures to demonstrate these interlocks.
8. Identify values for setpoints and inputs, positions of adjustable devices, valves, dampers, and switches.
9. Identify ranges of acceptable performance for each condition tested.
10. Write testing procedures as detailed test instructions, with sufficient step-by-step information to allow a test to be repeated under identical conditions with repeatable results.

B. Test Methods: Verify and test performance by manipulating equipment and observing performance and responses or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by portable data loggers.

1. Verify and test performance using actual conditions whenever possible.
2. Simulate conditions (example - impose an artificial load) as closely as possible to actual and anticipated conditions. Before simulating conditions, calibrate sensors, transducers, and devices. Set and document simulated conditions and methods of simulation. After test, return settings to normal operating conditions.

3. Alter setpoints when simulating conditions is not practical.
4. Overwrite sensor values with a signal generator when actual or simulated conditions and altering setpoints are not practical. Do not use sensor to act as the signal generator to simulate conditions or overwrite values.

C. Use indirect indicators for responses or performance only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings, through the control system, represent actual conditions and responses.

D. During functional testing when issues are identified, the CxA will review the issue with the Contractor.

1. When there is an issue and the Contractor accepts responsibility to correct it:
   a. The CxA documents the issues on the issues log and the prime contractor's response and intentions, and they go on to another test or sequence. The Prime Contractor will indicate a date that the correction will be completed. A copy is provided to the Contractor, CxA and to the Owners Representative. When the Contractor corrects the issues, signs a statement of correction, certifying that the equipment is ready to be retested, (this will be via e-mail) and sends it back to the CxA.
   b. The Contractor reschedules the test and coordinates with CxA to establish a time and date that the test is to be repeated.
2. If there is a dispute about an issue, regarding whether it is an issue or who is responsible:
   a. The issues shall be documented on the issues log with the Contractor's response and a copy given to the A/E and Owner's Representative and to the Contractor Representative assumed to be responsible.
   b. Other parties are brought into the discussions as needed to determine the compliance of the issues. Final interpretive authority is with the A/E. Final acceptance authority is with the A/E.
   c. The CxA documents the resolution process. Once the interpretation and resolution have been decided on that issue, the appropriate party corrects the deficiency, notifies the CxA. The Contractor reschedules and coordinates with CxA to establish a time and date that the test is to be repeated. This will occur until satisfactory performance is achieved.
3. All unresolved issues and deficiency items at substantial completion will be added to the A/E punchlist.

E. Cost of Retesting

1. The cost for the contractor to retest during functional testing, if they are responsible for the issues, shall be theirs. Contractor acknowledges that successful completion of pre-functional testing and documentation of same as described here-in certifies that the system, subsystem, or equipment has been tested by them and is ready for functional test by the CxA Team.
2. For issues identified, not related to any construction checklist or startup fault, the following shall apply: The CxA will direct the retesting of the equipment once at no "charge" to the Contractor for CxA time. However, the CxA's time for further retest will be charged to the Contractor. Contractor agrees to reimburse the CxA at the hourly rates included herein.
3. The time for the CxA to direct any retesting required because a specific construction checklist, start-up test, or pre-functional test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the Contractor. Contractor agrees to reimburse the CxA at the hourly rates included herein.
4. Items of non-compliance in material, installation or setup are corrected at the Contractors'/Sub-Contractors' expense and the system retested in accordance with

paragraph 3.5 of this section at the expense of the Contractor/Sub-Contractor who shall bear expenses of the CxA during retesting at $1600 per day or partial day.

F. Contractor agrees that the OA shall document and withhold payment and deduct from Contractor's retainage funds the necessary amounts as stated above to compensate the Commissioning Authority for retest after the second failed functional performance test.

3.4 Commissioning Schedule

Each Contractor involved with the installation, setup or field testing of equipment/components associated with systems to be commissioned shall participate as required to achieve a complete commissioning process. Equipment/Systems designated to be commissioned and required testing documentation for this project are described in product specification sections.

END OF SECTION

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Form-facing material for cast-in-place concrete.
   2. Shoring, bracing, and anchoring.

1.2 DEFINITIONS

A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 ACTION SUBMITTALS

A. Product Data: For each of the following:
   1. Exposed surface form-facing material.
   2. Concealed surface form-facing material.
   3. Form ties.
   4. Form-release agent.

B. Shop Drawings:
   1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
   2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
      a. Location of construction joints is subject to approval of the Architect.
   3. Indicate location of waterstops.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspection agency.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
   1. Build panel approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:
   1. Provide continuous, true, and smooth concrete surfaces.
   2. Furnish in largest practicable sizes to minimize number of joints.
   3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete, and as follows:
      a. Plywood, metal, or other approved panel materials.
      b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
         1) APA HDO (high-density overlay).
         2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
         3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
         4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
   1. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CETCO is a subsidiary of Minerals Technologies Inc.
      b. Carlisle Coatings & Waterproofing Inc.
      c. Concrete Sealants Inc.
      d. Henry Company.
      e. J P Specialties, Inc.
      f. Sika Corporation.

2.4 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
2. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:
1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
   a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings.
   a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that

is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete must be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work.
1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:
1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 032000- CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Concrete Joint Layout: Indicate proposed horizontal slab and vertical wall joints required to build the structure. Proposed joint submittal shall include joint spacing, layout, and type according to the Drawings and Specifications. Submittal shall include both contraction, “sawcut” joints, and construction joints between concrete placement(s).

1. Location of joints is subject to approval of the Architect.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

2. Mechanical splice couplers.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous shall have “Ls” lap as indicated on Drawings.
2. Stagger splices in accordance with ACI 318.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
2. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
3. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:
   1. Section 031000 "Concrete Forming and Accessories".
   2. Section 032000 "Concrete Reinforcing".
   3. Section 312000 "Earth Moving".
   4. Section 321313 "Concrete Paving".

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete Subcontractor.
   2. Review the following:
      a. Special inspection and testing and inspecting agency procedures for field quality control.
      b. Construction joints, control joints, isolation joints, and joint-filler strips.
      c. Semirigid joint fillers.
      d. Vapor-retarder installation.
      e. Anchor rod and anchorage device installation tolerances.
      f. Cold and hot weather concreting procedures.
      g. Concrete finishes and finishing.
      h. Curing procedures.
      i. Forms and form-removal limitations.
      j. Shoring and reshoring procedures.
      k. Methods for achieving specified floor and slab flatness and levelness.

l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
p. Protection of field cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.
1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Silica fume.
5. Aggregates.
6. Admixtures.
7. Vapor retarders.
8. Floor and slab treatments.
9. Liquid floor treatments.
10. Curing materials.
11. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Slump limit.
6. Air content.
7. Nominal maximum aggregate size.

C. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:
1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Curing compounds.
   4. Floor and slab treatments.
   5. Bonding agents.
   6. Adhesives.
   7. Vapor retarders.
   8. Semirigid joint filler.
   9. Joint-filler strips.
   10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:
   1. Portland cement.
   2. Fly ash.
   3. Slag cement.
   4. Silica fume.
   5. Aggregates.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.

B. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

C. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

D. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
   1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

E. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

F. Mockups: Cast concrete formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

1. Formed Surfaces: Build panel approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
2. Exposed Columns: mockup in the location indicated or, if not indicated, as directed by Architect.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Cementitious Materials:
1. Portland Cement: ASTM C150/C150M, Type I/II.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C33/C33M, coarse aggregate, graded. Provide aggregates from a single source.
1. Alkali-Silica Reaction: Comply with one of the following:
a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.

b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.

c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2. Maximum Coarse-Aggregate Size: As indicated on Drawings.

3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C260/C260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.

2. Retarding Admixture: ASTM C494/C494M, Type B.

3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

7. Set-Accelerating Corrosion Inhibiting Admixture: ASTM C1582/C1582M.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

1) Cortec MCI 2005NS.

E. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

2.3 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Barrier-Bac; Inteplast Group.

b. Stego Industries, LLC.

c. W.R. Meadows, Inc.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

a. BASF Corporation; MasterKure ER 50.

b. ChemMasters, Inc; Spray-Film.

c. Euclid Chemical Company (The); an RPM company; Eucobar.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
   1. Color:
      a. Ambient Temperature Below 50 deg F: Black.
      b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
      c. Ambient Temperature Above 85 deg F: White.

D. Water: Potable or complying with ASTM C1602/C1602M.

E. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ChemMasters, Inc.
      b. Dayton Superior.
      c. Euclid Chemical Company (The); an RPM company.
      d. SpecChem, LLC.
      e. W.R. Meadows, Inc.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:
   1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent

floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.7 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, for concrete for parking structure slabs, and concrete with a w/cm below 0.50.

2.8 CONCRETE MIXTURES

A. As indicated on Drawings.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each

additional 1 cu. yd..

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
   2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
   1. Daily access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
   4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
   1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
   1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
   2. Face laps away from exposed direction of concrete pour.
   3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
   4. Lap joints 6 inches and seal with manufacturer's recommended tape.
   5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
   6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.

7. Protect vapor retarder during placement of reinforcement and concrete.
    a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
    a. Continue reinforcement across construction joints unless otherwise indicated.
    b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
8. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated on Drawings. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.

2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
   1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
   2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
   1. If a section cannot be placed continuously, provide construction joints as indicated.
   2. Deposit concrete to avoid segregation.
   3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
   4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
      a. Do not use vibrators to transport concrete inside forms.
      b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
      c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
      d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Do not place concrete floors and slabs in a checkerboard sequence.
   2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   3. Maintain reinforcement in position on chairs during concrete placement.
   4. Screed slab surfaces with a straightedge and strike off to correct elevations.
   5. Level concrete, cut high areas, and fill low areas.
   6. Slope surfaces uniformly to drains where required.

7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:
   1. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
      a. Locations: Apply to concrete surfaces not exposed to public view.
      b. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
      c. Remove projections larger than 1/4 inch.
      d. Patch tie holes.
      e. Surface Tolerance: ACI 117 Class B.
   2. ACI 301 Surface Finish SF-3.0:
      a. Locations: Apply to concrete surfaces exposed to public view.
      b. Provide field mock-up for review by architect to establish acceptable finish.
      c. Maintain required patterns or variances indicated in Drawings or to match mockup(s).
      d. Fill air holes
      e. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
      f. Remove projections.
      g. Patch tie holes.
      h. Surface Tolerance: ACI 117 Class A.
      i. Skim coat with Portland cement and sand smooth.

B. Related Surfaces:
   1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces. Provide level surface complying with installation requirements for installation of flashing, wall studs and sheathing materials, etc. Repair edges damaged by form stripping.
   2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:
   1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
   2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
   3. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish:
   1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently

to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.

2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing.

D. Trowel Finish:
1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
   a. Slabs on Ground: as indicated on Drawings.
   b. Suspended Slabs: as indicated on Drawings.

E. Trowel and Fine-Broom Finish:
1. Apply: locations indicated on Architectural Finish Drawings
2. First apply trowel finish to surfaces. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
3. Coordinate required final finish with Architect before application.
4. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Architectural Finish Drawings.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:
1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases as indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: match concrete specified of supporting floor.
4. Install dowel rods to connect concrete base to concrete floor as indicated on Drawings.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:
1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
        1) Recoat areas subject to heavy rainfall within three hours after initial application.
        2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:
    a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
   a) Lap edges and ends of absorptive cover not less than 12-inches.
   b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.
   a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
   b) Cure for not less than seven days.
3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
   a) Water.
   b) Continuous water-fog spray.

b. Floors to Receive Polished Finish: Contractor has option of the following:
1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
   a) Lap edges and ends of absorptive cover not less than 12 inches.
   b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
   a) Water.
   b) Continuous water-fog spray.

c. Floors to Receive Urethane Flooring:
1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

d. Floors to Receive Curing Compound:
1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

e. Floors to Receive Curing and Sealing Compound:
   1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
   2) Recoat areas subjected to heavy rainfall within three hours after initial application.
   3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

A. Conform to ACI 117.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
   1. Defer joint filling until concrete has aged according to manufacturer’s instructions.
   2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete:
   1. Repair and patch defective areas when approved by Architect.
   2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
      a. Limit cut depth to 3/4 inch.
      b. Make edges of cuts perpendicular to concrete surface.
      c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
      d. Fill and compact with patching mortar before bonding agent has dried.
      e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
      a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
      b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:
   1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
      a. Correct low and high areas.
      b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   3. After concrete has cured at least 14 days, correct high areas by grinding.
   4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
      a. Finish repaired areas to blend into adjacent concrete.
   5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
      a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
      b. Feather edges to match adjacent floor elevations.
   6. Correct other low areas scheduled to remain exposed with repair topping.
      a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
      b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
      a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
      b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
      c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
      d. Place, compact, and finish to blend with adjacent finished concrete.
      e. Cure in same manner as adjacent concrete.
   8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
      a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
      b. Dampen cleaned concrete surfaces and apply bonding agent.
      c. Place patching mortar before bonding agent has dried.
      d. Compact patching mortar and finish to match adjacent concrete.
      e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results.
        13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with

ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
    a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;.
    a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M:
    a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
5. Compressive-Strength Tests: ASTM C39/C39M.
    a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
8. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
9. Additional Tests:
    a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
        1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.
10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 72 hours of completion of floor finishing and promptly report test results to Architect.

3.15 PROTECTION

A. Protect concrete surfaces as follows:
   1. Protect from petroleum stains.
   2. Diaper hydraulic equipment used over concrete surfaces.
   3. Prohibit vehicles from interior concrete slabs.
   4. Prohibit use of pipe-cutting machinery over concrete surfaces.
   5. Prohibit placement of steel items on concrete surfaces.
   6. Prohibit use of acids or acidic detergents over concrete surfaces.
   7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03300

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Embedded flashing.
6. Miscellaneous masonry accessories.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

    a. Include material test reports substantiating compliance with requirements.
    b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include name of manufacturer, brand name, and type.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test in accordance with ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
2. Include test reports, in accordance with ASTM C1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602/ACI 530.1/ASCE 6.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

F. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified in accordance with ASTM C1093 for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for typical exterior wall in sizes approximately 96 inches (2400 mm) long by 72 inches (1800 mm) high by full thickness, including face and backup wythes and accessories.

a. Include a sealant-filled joint at least 16 inches (400 mm) long in exterior wall mockup.
b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).

2. Protect accepted mockups from the elements with weather-resistant membrane.
3. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

    a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
    b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602/ACI 530.1/ASCE 6.
2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.

B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

1. Where fire-resistance-rated construction is indicated, units are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS (CMU-1)

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners unless otherwise indicated.

B. CMUs: ASTM C90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength as indicated on Drawings.
2. Density Classification: Normal weight unless otherwise indicated.
3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less-than-nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

2.5 MASONRY LINTELS

A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

1. Alkali content is not more than 0.1 percent when tested in accordance with ASTM C114.

B. Hydrated Lime: ASTM C207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

E. Aggregate for Grout: ASTM C404.

F. Cold-Weather Admixture: Not allowed.

G. Water: Potable.

2.7 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60 (Grade 420).

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

1. Interior and Exterior Walls: Stainless steel.
2. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
3. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
4. Spacing of Cross Rods: Not more than 16 inches (407 mm) o.c.
5. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

2.8 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches (38 mm) into masonry but with at least a 5/8-inch (16-mm) cover on outside face.

B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:

1. Stainless Steel Wire: ASTM A580/A580M, Type 304.
2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, stainless steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-) diameter, stainless steel wire.

D. Partition Top Anchors: 0.105-inch- (2.66-mm-) thick metal plate with a 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from stainless steel.

E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTMA 153/A153M.

2.9 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch (0.40 mm) thick.
2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
4. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
5. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate metal expansion-joint strips and end dams from stainless steel to shapes indicated.
7. Solder metal items at corners. Fabricate fully soldered end dams.

B. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

C. Termination Bars for Flashing (TWF-1): Stainless steel bars 1/8 inch by 1 inch (3.2 mm by 25 mm).

2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.11 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement and lime.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that would impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.

B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement. Provide a maximum control joint spacing per ACI 530/NCMA TEK-Notes. Control and expansion joints are to meet NCMA standards.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.10 FLASHING

A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
3. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated. Set drip edge in a bead of sealant.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 REINFORCED UNIT MASONRY

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.12 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.

B. Inspections: Special inspections in accordance with Level B C in TMS 402/ACI 530/ASCE 5.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.

G. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.

H. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at 7 days and at 28 days.

3.13 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry within 24 to 48 hours and as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.14 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042200

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Shear stud connectors.
3. Shrinkage-resistant grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members not to be shop primed.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand-critical welds.

D. Delegated-Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Fabricator.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural-steel materials, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.

F. Source quality-control reports.

G. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category.

B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.

C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
2. RCSC's "Specification for Structural Joints Using High-Strength Bolts."

B. Connection Design Information:

1. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.

C. Moment Connections: Type FR, fully restrained.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A992/A992M.

B. Channels, Angles: ASTM A36/A36M.

C. Plate and Bar: ASTM A36/A36M or ASTM A572/A572M, Grade 50 as noted in the Drawings.

D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

E. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts or Grade F1852 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.

B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type

with plain finish.

C. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

A. Anchor Rods: ASTM F1554, Grade 36 or ASTM F1554, Grade 55 with weldable supplement, as noted in the Drawings.

1. Configuration: Straight.
2. Nuts: ASTM A563 heavy-hex carbon steel.
3. Plate Washers: ASTM A36/A36M carbon steel.
4. Washers: ASTM F436, Type 1, hardened carbon steel.
5. Finish: Plain.

2.5 PRIMER

A. Steel Primer:

1. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanized-Steel Primer: MPI#134.

1. Etching Cleaner: MPI#25, for galvanized steel.
2. Galvanizing Repair Paint: ASTM A780/A780M.

2.6 SHRINKAGE-RESISTANT GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 2.

F. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using automatic end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated in the Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.10 SHOP PRIMING

A. Shop prime steel surfaces to receive paint, except:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Corrosion-resisting (weathering) steel surfaces.
7. Surfaces enclosed in interior construction.

B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:

1. SSPC-SP 3.

C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner.

D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

B. Baseplates Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. When indicated in the Drawings, weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

C. Maintain erection tolerances of structural steel within ANSI/AISC 303.

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

1. Joint Type: As indicated in the Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 REPAIR

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

B. Touchup Painting:

1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

    a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures in accordance with AISC 341 quality assurance, Chapter J.

        1) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

        2) Ultrasonic Inspection: ASTM E164.

END OF SECTION 051200

SECTION 052100 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. LH-series long-span steel joists.
3. Steel joist girders.
4. Steel joist accessories.

B. Related Requirements:
1. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.2 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Welding certificates.

C. Manufacturer certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Mill Certificates: For each type of bolt.

F. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Canam Steel Corporation; Canam Group, Inc.
2. New Millennium Building Systems, LLC.
3. Nucor Corp.

2.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.

1. Use ASD; data are given at service-load level.
2. Design special joists to withstand design loads with live-load deflections no greater than the following:
a. Roof Joists: Vertical deflection of 1/240 of the span.

2.3 STEEL JOISTS

A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top-

and bottom-chord members; of joist type and end and top-chord arrangemenets as indicated on Drawings.

B. Long-Span Steel Joist: Manufactured steel joists according to "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated on Drawings.

2.4 STEEL JOIST GIRDERS

A. Manufactured joist girders according to "Standard Specification for Joist Girders" in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements as indicated on Drawings.

2.5 PRIMERS

A. Primer:
1. Provide shop primer that complies with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

2.6 STEEL JOIST ACCESSORIES

A. Bridging:

1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

1. Finish: Plain.

C. Welding Electrodes: Comply with AWS standards.

D. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.7 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Shop priming of joists and joist accessories is specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 REPAIRS

A. Touchup Painting:

1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories.

    a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
    b. Apply a compatible primer of same type as primer used on adjacent surfaces.

2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

C. Visually inspect bolted connections.

D. Prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Roof deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of steel deck.

B. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.

C. Research Reports: For steel deck, from ICC-ES.

D. Field quality-control reports.

E. Qualification Statements: For welding personnel.

F. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:

1. AWS D1.1/D1.1M.
2. AWS D1.3/D1.3M.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
   1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ASC Profiles, Inc.
   2. Canam Steel Corporation; Canam Group, Inc.
   3. Epic Metals Corporation.
   4. New Millennium Building Systems, LLC.
   5. Nucor Corp.
   6. Verco Decking, Inc., a Nucor company.

B. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
   1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), as indicated in Drawings.
   2. Deck Profile: As indicated in Drawings.
   3. Profile Depth: As indicated in Drawings.
   4. Design Uncoated-Steel Thickness: As indicated in Drawings.
   5. Span Condition: Triple span or more.
   6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.3 ACCESSORIES

A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: as indicated on Drawings.

C. Side-Lap Fasteners: as indicated on Drawings.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

F. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 INSTALLATION OF ROOF DECK

A. Fasten roof-deck panels to steel supporting members as indicated in the Drawings.

B. Side-Lap and Perimeter Edge Fastening: as indicated in the Drawings.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 4 inches (50 mm) minimum.

D. Roof Sump Pans : Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (300 mm) apart with at least one fastener at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures,

and reinforcing channels in accordance with deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Prepare test and inspection reports.

3.5 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION – 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Exterior non-load-bearing wall framing.
2. Interior non-load-bearing wall framing exceeding the height limitations of standard, nonstructural metal framing.
3. Interior load bearing framing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel framing, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Evaluation Reports:

1. For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ClarkDietrich.
2. MarinoWARE.
3. Nuconsteel, A Nucor Company.
4. The Steel Network, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed in the project state to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

a. Exterior Non-Load-Bearing Framing, unless noted otherwise: Horizontal deflection of 1/360 of the wall height.

b. Exterior Non-Load-Bearing Framing at jambs for exterior glazing systems: Coordinate deflection limits with glazing system supplier.
c. Exterior Non-Load-Bearing Framing backing up masonry veneer: Horizontal deflection of 1/600 of the wall height.
d. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft..

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

a. Upward and downward movement of: As indicated on Drawings.

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As required by structural performance.
2. Coating: G90 or equivalent for framing backing up exterior walls. G60 or equivalent elsewhere.

B. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G90.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (18 gage).
2. Flange Width: As required by structural performance.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0329 inch (20 gage).
2. Flange Width: As required by structural performance.

C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole-reinforcing plates.
11. Backer plates.

2.6 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58, or ICC-ES AC308 as appropriate for the substrate.

C. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.7 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: MIL-P-21035B or SSPC-Paint 20.

B. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

C. Sill Sealer Gasket: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

2.8 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Install sill sealer gasket at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated or when installing into slip track. Space studs as required for structural performance determined by Delegated Engineer and indicated in Shop Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Connect vertical deflection clips to bypassing studs and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF INTERIOR NONLOADBEARING WALL FRAMING

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated or when installing into slip track. Space studs as required for structural performance determined by Delegated Engineer and indicated in Shop Drawings.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to studs and anchor to building structure.
4. Connect drift clips to cold-formed steel metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.7 REPAIR

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.8 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Metal ladders.
3. Metal ships' ladders.
4. Metal bollards.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Fasteners.
2. Shop primers.
3. Shrinkage-resisting grout.
4. Manufactured metal ladders.
5. Metal ships' ladders.
6. Metal bollards.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Metal ladders.
3. Metal ships' ladders.
4. Metal bollards.

C. Delegated Design Submittals: For miscellaneous supports, framing, and ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

C. Research Reports: For post-installed anchors.

D. Delegated design engineer qualifications.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design miscellaneous supports, framing, and ladders.

B. Structural Performance of Aluminum Ladders: Ladders, including landings, are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

D. Aluminum Plate and Sheet: ASTM B209 (ASTM B209M), Alloy 6061-T6.

E. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T6.

F. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ISO 898-1, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, (ASTM A563M, Class 10S3) heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593 (ISO 3506-1); with hex nuts, ASTM F594 (ASTM F836M); and, where indicated, flat washers; Alloy Group 2 (A4).

E. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

F. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

G. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 (A4) stainless steel bolts, ASTM F593 (ISO 3506-1), and nuts, ASTM F594 (ASTM F836M).

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications. In applications where grout installation may be subjected to moisture, the manufacturer shall submit a letter stating the entire grout matrix does not contain any of the following; added gypsum, plaster-of-paris, or sulfur trioxide levels in a portland cement component exceeding ASTM C150's published limits.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for overhead doors from continuous steel members of sizes indicated with attached bearing plates, anchors, and braces as recommended by the product’s manufacturer and as designed by the delegated design engineer.

D. Galvanize miscellaneous framing and supports where indicated.

E. Prime miscellaneous framing and supports with primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.7 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

2. Design and manufacture to meet or exceed requirements of OSHA standard 1910.23 and 1910.28 as applicable.

B. Aluminum Ladders (MET LAD-2 & MET LAD-3):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kattsafe; Model No. RL35 Vertical Fixed Ladder with 3 ft. Walkway Kit including (1) 6 ft long section of GR34 Non-Penetrating Guardrail on each side (MET LAD-2) and Model No. RL31 Vertical Fixed Ladder with Grab Rails (MET LAD-3) or approved equal.

2. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
3. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches (64 mm) deep, 3/4 inch (19 mm) wide, and 1/8 inch (3.2 mm) thick.
4. Rungs: Extruded-aluminum tubes, not less than 3/4 inch (19 mm) deep and not less than 1/8 inch (3.2 mm) thick, with ribbed tread surfaces.
5. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
6. Provide platforms as indicated fabricated from extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch (12 mm) in least dimension.
7. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted aluminum brackets using Kattsafe Standard Ladder Fixing Bracket Model No. LD421.280.
8. Finish: Mill finish aluminum (MET LAD-2), Powder Coated (MET LAD-3).

2.8 METAL SHIPS' LADDERS (MET LAD-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide FS Industries; IBC Design Flush Top Tread Ships Ladder - 60 deg Steep Incline with Walk-Thru Handrail or approved equal.

B. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads are not to be less than 5 inches (127 mm) exclusive of nosing or less than 8-1/2 inches (216 mm) including the nosing, and riser height is not to be more than 9-1/2 inches (241 mm).
2. Fabricate ships' ladders, including railings from steel.
3. Fabricate treads from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 1/2 inch (12 mm) in least dimension.

C. Galvanize, prime and field paint steel ships' ladders, including treads, railings, brackets, and fasteners.

2.9 METAL BOLLARDS (MET FAB-1 & MET FAB-2)

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Innoplast; 4” U-Shaped Pipe Guards (MET FAB-2) or approved equal.

2. Size: 36” W x 56” H.

B. Prime steel bollards with primer specified in Section 099600 "High-Performance Coatings."

2.10 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.11 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer unless primers specified in Section 099600 "High-Performance Coatings" are indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.12 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

3.3 INSTALLATION OF METAL LADDERS

A. Secure ladders to adjacent construction with the clip angles attached to the stringer.

B. Install brackets as required for securing of ladders welded or bolted to structural steel or built into masonry or concrete.

3.4 INSTALLATION OF METAL SHIPS' LADDERS

A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.

3.5 INSTALLATION OF METAL BOLLARDS

A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.6 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel railings.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Fasteners.
2. Shop primer.
3. Bituminous paint.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including top rails, posts, and balusters, including finish.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, and infill. Sample need not be full height.

a. Show method of connecting and finishing members at intersections.

D. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For delegated design professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

E. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 STEEL RAILINGS (ORN RAIL-1)

A. Tubing: ASTM A500/A500M (cold formed). Size as indicated on Drawings.

1. Provide galvanized finish for where indicated.

B. Plates, Shapes, and Bars: ASTM A36/A36M.

C. Cast Iron Fittings: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.4 FASTENERS

A. Fastener Materials:

1. Hot-Dip Galvanized Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
2. Finish exposed fasteners to match appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction and capable of withstanding design loads.

C. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.

B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

E. Intermediate Coats and Topcoats: Provide products that comply with Section 099600 "High-Performance Coatings."

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately.

1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
2. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

F. Connections: Fabricate railings with welded connections unless otherwise indicated.

G. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay.

H. Form changes in direction as follows:

1. As detailed.

I. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

J. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.

1. Fabricate anchorage devices capable of withstanding loads imposed by railings.

2. Coordinate anchorage devices with supporting structure.

2.7 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize indicated steel railings, including hardware, after fabrication.
2. Comply with ASTM A123/A123M for hot-dip galvanized railings.
3. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
4. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows.

1. Comply with SSPC-SP 16.

D. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Perform cutting, drilling, and fitting required for installing railings.

1. Fit exposed connections together to form tight, hairline joints.
2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
5. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).

B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches (50 mm) beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches (150 mm) of post.

3.3 ANCHORING POSTS

A. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:

1. For steel railings, weld flanges to post and bolt to metal supporting surfaces.

3.4 ATTACHING RAILINGS

A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

3.5 REPAIR

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

    a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

3.6 CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 055213

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wood blocking and nailers.
2. Plywood backing panels.

B. Related Requirements:

1. Section 061600 "Sheathing" for sheathing.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.
5. Metal framing anchors.

B. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal (38-mm actual) thickness or less, 19 percent for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS (WD BLKG-2)

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS (WD BLKG-1)

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece.

E. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not bleed through, contain colorants, or otherwise adversely affect finishes.

F. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.
2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening to Metal Framing: ASTM C1002 or ASTM C954, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Grade A1 or A4).

2.7 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function

of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

I. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.3 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for plywood backing panels.
2. Section 072726 “Fluid-Applied Membrane Air Barriers.”

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated plywood.
2. Fire-retardant-treated plywood.

B. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

B. Factory mark panels to indicate compliance with applicable standard.

2.2 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.3 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat plywood indicated on Drawings.

2.4 WALL SHEATHING (GYP SHTG-1)

A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed LLC; Saint-Gobain North America; GlasRoc.
b. Continental Building Products, LLC; Weather Defense.
c. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
d. National Gypsum Company; Gold Bond® eXP® Sheathing.
e. USG Corporation; Securock.

2. Type and Thickness: As indicated on Drawings.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For wall sheathing, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch (0.835 mm) thick, use screws that comply with ASTM C1002.
2. For steel framing from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick, use screws that comply with ASTM C954.

2.6 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Section 079200 "Joint Sealants." Coordinate sheathing board joint treatment with the requirements of the air/vapor/water barrier manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. ICC-ES evaluation report for fastener.

D. Coordinate sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to cold-formed metal framing with screws.

2. Install panels with a 3/8-inch (9.5-mm) gap where non-load-bearing construction abuts structural elements.
3. Install panels with a 1/4-inch (6.4-mm) gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.

C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.

D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.

1. Space fasteners approximately 8 inches (200 mm) o.c. and set back a minimum of 3/8 inch (9.5 mm) from edges and ends of panels.

E. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings. Coordinate sheathing board joint treatment with the requirements of the air/vapor/water barrier manufacturer.

END OF SECTION 061600

SECTION 070543.11 - COMPOSITE METAL HYBRID (CMH) CONTINUOUS INSULATION SUB-FRAMING SUPPORT SYSTEMS

PART 1- GENERAL

1.01 SECTION INCLUDES

A. Composite metal hybrid (CMH) sub-framing support system with in-fill continuous insulation integrated within exterior wall cladding.

1. Substrate: Exterior sheathing over metal stud framing. Concrete masonry units (CMU).

1.02 RELATED REQUIREMENTS

A. Section 042200 – Concrete Unit Masonry.

B. Section 054000 – Cold-Formed Metal Framing: Metal stud substrate support framing.

C. Section 061600 – Sheathing.

D. Section 072100 – Thermal Insulation.

E. Section 072726 – Fluid-Applied Membrane Air Barriers.

F. Section 074213.13 – Formed Metal Wall Panels.

G. Section 079200 – Joint Sealants: Perimeter sealant.

1.03 REFERENCE STANDARDS

A. ASCE American Society of Civil Engineers (www.asce.org).

1. ASCE 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2022.

B. ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers (www.ashrae.org).

1. ASHRAE 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019.

2. ASHRAE 189.1 – Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings; 2020.

C. ASTM International (American Society for Testing and Materials; www.astm.org).

1. ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2022.

2. ASTM C303 - Standard Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation; 2021.

3. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

4. ASTM C1177/C1177M – Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

5. ASTM C1289 – Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2022a.

6. ASTM C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus; 2019.

7. ASTM C1396/C1396M – Standard Specification for Gypsum Board; 2017(2022).

8. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 10(2018).

9. ASTM D570 – Standard Test Method for Water Absorption of Plastics; 2022.

10. ASTM D635 – Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

11. ASTM D638 – Standard Test Method for Tensile Properties of Plastics; 2022.

12. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between minus 30 degrees C and 30 degrees C with a Vitreous Silica Dilatometer; 2016.

13. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.

14. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement; 2020.

15. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016.

16. ASTM D1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2020.

17. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics; 2017.

18. ASTM D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging; 2020.

19. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.

20. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products; 2019.

21. ASTM D6641/D6641M - Standard Test Method for Compressive Properties of Polymer Matrix Composite Materials Using a Combined Loading Compression (CLC) Test Fixture; 2016e2.

22. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.

23. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a.

24. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.

25. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference; 2014(2021).

26. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

D. IBC – International Building Code (ICC - International Code Council); 2021.

E. IECC – International Energy Conservation Code; 2021.

F. IgCC – International Green Construction Code; 2021.

G. NFPA – National Fire Protection Association (www.nfpa.org).

1. NFPA 285 – Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate installation of continuous insulation sub-framing support system as indicated on drawings for proper drainage, flashing, trim, backup support, soffits, and other related Work.

1. Review and finalize construction schedule.

2. Verify availability of materials, installer's personnel, equipment, and facilities needed to meet established schedule.

3. Review means and methods related to installation in accordance with manufacturer's installation instructions.

4. Examine support conditions for compliance with installation requirements, including alignment and attachment to structural support system.

5. Review flashings, wall cladding details, wall penetrations, drainage plane, openings, and condition of other construction that is related to this Work.

6. Review temporary protection requirements for during and after installation of this Work.

1.05 SUBMITTALS

A. Product Data: Submit for each product being used and as indicated, including installation details, material descriptions, dimensions of individual components and profiles, and necessary accessories for a complete assembled system.

1. Continuous insulation (CI) support system attachment methods and required fasteners.

2. Wall-mounted items, including doors, windows, louvers, and light fixtures.

3. Wall penetrations, including pipes, electrical fixtures, and any other wall-mounted utilities.

B. Shop Drawings: Submit project specific shop drawings prepared by, or under supervision of, Structural Design Engineer as specified in Quality Assurance article below and including Structural Design Engineer’s stamp or seal on all shop drawings including system attachments and anchors.

1. Include fabrication and installation layouts of system; project specific details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, accessories, and special details. Include details showing integration of metal composite material wall panel system with air barrier system.
2. Accessories: Include project specific details of flashing, trim, and anchorage, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
3. Provide signed and sealed drawings, by a qualified design professional in Project jurisdiction, of system showing compliance with performance requirements and design criteria identified for this Project.

B. Test and Inspection Reports: Submit test and inspection reports on each type of wall cladding/veneer system based on evaluation of comprehensive tests performed by testing agency approved by authorities having jurisdiction.

C. Warranty: Submit manufacturer’s warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least three years of documented experience.

B. Installer Qualifications: Company specializing in performing work as indicated in this section with at least three years of documented experience and approved by manufacturer.

C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site without damage or deformation in manufacturer's original unopened containers and with labels that clearly identify product name and manufacturer.

B. Storage: Store materials in clean, dry, and level interior or exterior areas for limited duration in accordance with manufacturer's written instructions.

C. Protect components during transportation, handling, and installation from moisture, excessive temperatures, and other construction operations in accordance with manufacturer's written instructions.

D. Handle components in accordance with manufacturer's written instructions and in a manner to prevent bending, warping, twisting, and surface, edge, or corner damage.

1.08 SITE CONDITIONS

A. Weather Limitations: Only proceed with installation when existing and forecasted weather conditions allow for assembly of this Work in accordance with manufacturer's written installation instructions.

1.09 WARRANTY

A. Manufacturer’s Warranty: Provide 1-year manufacturer’s warranty for composite metal hybrid (CMH) sub-framing support system commencing on the date of Substantial Completion.

PART 2- PRODUCTS

2.01 MANUFACTURER

A. Basis-of-Design Product: Subject to compliance with requirements, provide Advanced Architecural Products (A2P); GreenGirt CMH Sub-Framing System; SMART ci 1 in 1 (FRP FURG-1) System or comparable product by one of the following;

B. Armetherm Thermal Bridging Solutions; Armatherm Z Girt.

C. Strongwell; STRONGIRT.

2.02 DESCRIPTION

A. Attach CMH sub-framing support system components through exterior sheathing into metal stud framingto concrete masonry units (CMU) as indicated on drawings.

B. Install CMH sub-framing support system components horizontally or vertically through exterior sheathing into stud support system as indicated on drawings in compliance with project requirements.

C. Install metal hat channel as indicated on drawings, mounted horizontally to vertical or vertically to horizontal CMH sub-framing support system, connecting adjacent supports in series to each other.

2.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide system tested in accordance with ASTM E330/E330M and certified to be without permanent deformation or failure of structural members in accordance with design wind velocities for project location and potential for occurance based on data from wind velocity maps and other provisions of ASCE 7 and as approved by authorities having jurisdiction (AHJ).

1. Design Loads: As indicated on Drawings.

Measure performance of assembly using test loads equal to 1-1/2 times design wind loads indicated and with 10-second duration at maximum pressure.

B. System Thermal Design: Ensure that installed continuous insulation and CMH sub-framing support system, and cladding attachment does not have thermal bridging of fasteners or framing that creates a continuous metal path from exterior surface of insulation to interior face of insulation.

1. Verify that system thermal design meets or exceeds thermal design requirements in accordance with ASHRAE 90.1 ASHRAE 189.1 IECC or IgCC energy code.

2. Thermal Resistance, Overall: Refer to Architectural Exterior Wall Types on Drawings.

3. Thermal Performance Test: Provide thermal resistance (R-value) indicated, in accordance with ASTM C1363, corrected to 15 mph wind outside and still air inside, with installed condition including fasteners and joints.

a. Provide efficiency of no less than 93 to 98 percent, with a maximum temperature differential of 18 degrees F from interior wall surface to interior wall cavity and node locations with a 70 degrees F exterior to interior wall temperature delta.

b. Provide test unit with at least one insulation panel horizontal and vertical joint length and height of test chamber area.

c. Provide finite element analysis of three-dimensional simulation of described wall assembly sealed by a professional engineer in compliance with code performance requirements and exceeding it by at least 3 percent.

C. Temperature Range: Comply with structural loading requirements within a temperature range of minus 55 degrees F to 180 degrees F.

D. Fire-Resistance Ratings: Provide CMH sub-framing support system with fire testing in accordance with ASTM E119 test methods and applied by approved testing agency acceptable to authorities having jurisdiction (AHJ).

1. Surface Burning Characteristics: Test in accordance with ASTM E84 test method for continuous insulation, composite metal hybrid (CMH) and interior surfaces as follows:

a. Flame Spread Index (FSI): 25 or less.

b. Smoke Developed Index (SDI): 450 or less.

Intermediate Scale Multistory Fire Test: Comply with NFPA 285 and/or IBC acceptance criteria for wall height above grade and fire separation distances when wall type and other noted conditions require such testing or compliance with requirements as indicated.

2.04 COMPOSITE METAL HYBRID (CMH) SUB-FRAMING SUPPORT SYSTEM

A. CMH Sub-Framing Support System: Provide CMH sub-framing support system consisting of polyester resin matrix with recycled materials, fire retardant additives and reinforced with integral continuous metal inserts the full length with pre-drilled holes to align with substrate fastening locations.

1. Length of CMH Support System: 96 inches long.
2. Depth of CMH Support System: Refer to Architectural Wall Types on Drawings.
3. Grid Spacing of CMH Sub-Framing Supports for Substrate Attachments: Refer to Architectural Wall Types on Drawings.
4. Fastener Retention System: Provide continuous galvanized steel insert for engagement of fasteners, at least 16 gauge thick, with G90 galvanized coating in accordance with ASTM A653/A653M.

a. Fasten CMH sub-framing support and other wall cladding support accessories through steel insert located within top and bottom of CMH sub-framing.
b. Provide at least 3 inch overlap of metal inserts between CMH supports with 3/16 inch wide gap; sealant is not required.

5. Provide integral compression seal within CMH sub-framing to ensure insulation will not dislodge.
6. Provide integral anti-siphon grooves on exterior and interior flanges of CMH sub-framing.
7. Provide force distribution zones integrally designed into profile of CMH sub-framing.
8. CMH sub-framing is self-extinguishing in accordance with ASTM D635.
9. Visual defects in CMH sub-framing is classified in accordance with ASTM D4385.
10. Tensile Properties: Engineered lengthwise and crosswise tensile properties of CMH sub-framing comply with performance loading criteria and specified safety factors in accordance with ASTM D638.
    a. Lengthwise 50,000 psi and crosswise 40,000 psi, minimum.
11. Compressive Properties: Engineered lengthwise and crosswise compressive properties of CMH sub-framing comply with performance loading criteria and specified safety factors in accordance with ASTM D6641/D6641M.
    a. Lengthwise 50,000 psi and crosswise 30,000, minimum.
12. Flexural Properties: Engineered lengthwise and crosswise flexural properties of CMH sub-framing comply with performance loading criteria and specified safety factors in accordance with ASTM D790.
    a. Lengthwise 50,000 psi and crosswise 40,000 psi, minimum.
13. Modulus of Elasticity: CMH sub-framing is engineered to meet performance loading criteria and specified safety factors in accordance with ASTM D638.
    a. Lengthwise 29,000,000 psi and crosswise 3,300,000 psi, minimum.
14. Water Absorption: CMH sub-framing absorbs less than 0.46 percent by weight within 24 hours when tested in accordance with ASTM D570.
15. Relative Density: CMH sub-framing is within range of 0.062 to 0.070 lbs/cubic inch when tested in accordance with ASTM D792.
16. Coefficient of Linear Thermal Expansion: CMH sub-framing is at 7.0 x 10^{-6} inch/inch/degrees F when tested in accordance with ASTM D696.
17. Notched Izod Pendulum Impact Resistance, Lengthwise: CMH sub-framing is at 160 ft lbs/inch when tested in accordance with ASTM D256 within standard temperature range.
18. Notched Izod Pendulum Impact Resistance, Crosswise: CMH sub-framing is at 100 ft lbs/inch when tested in accordance with ASTM D256 within standard temperature range.

2.05 ASSEMBLY

A. Assemble CMH sub-framing support system in accordance with manufacturer's installation instructions and as necessary to comply with performance requirements indicated.

1. Comply with CMH sub-framing support system dimensional and structural requirements as indicated on drawings.

2. Install CMH sub-framing support system in acceptable sequence in accordance with manufacturer's written installation instructions.

3. Install spray foam sealant on backside of cantilevered fasteners that completely puncture insulation layer.

2.06 ACCESSORIES

A. Provide necessary accessories for complete installation of CMH sub-framing support system including metal closure trim, transition angle, strapping, tie-in brackets, and other similar items.

B. Fasteners: Corrosion-resistant, self-tapping and self-drilling screws, bolts, nuts, and other fasteners as recommended by CMH sub-framing support system manufacturer for CMH materials and other project applications.

1. Cladding to CMH: Use standard self-tapping metal screws.

2. CMH to Metal Stud Wall Framing: Use standard self-tapping metal screws.

3. CMH to Concrete or Concrete Masonry Units (CMU): Use standard masonry or concrete screw anchors in pre-drilled hole.

5. Use of powder, air, or gas-actuated fasteners or actuated fastener tools is not permitted.

6. Use of impact wrenches when fastening to or from CMH is not permitted.

PART 3- EXECUTION

3.01 EXAMINATION

A. Examine areas of this Work, substrates, and other project conditions with installer present to verify compliance with requirements for installation tolerances, substrates, CMH sub-framing support system conditions, and other conditions relating to this Work.

B. Examine structural wall framing to ensure that angles, channels, studs, and other structural support members have been installed within alignment tolerances in accordance with installation instructions of CMH sub-framing support system manufacturer.

C. Examine components and systems penetrating CMH sub-framing support system prior to installation during rough-in stage of construction to coordinate actual locations of penetrations relative to CMH sub-framing support systems joint locations.

D. Verify that mechanical and electrical-related installations for exterior walls have been completed, and verify that adjacent materials and finishes are dry and ready for insulation installation.

E. Proceed with installation of CMH sub-framing support system only after wall substrate surfaces have been properly prepared and unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare substrate surfaces using methods recommended in writing by CMH sub-framing support system manufacturer to achieve excellent results under project conditions.

C. Prepare sub-framing, base angles, sills, furring, and other CMH sub-framing support system components and provide anchorage in accordance with ASTM C754 for substrate and wall cladding types in accordance with manufacturer's installation instructions.

3.03 INSTALLATION

A. Install CMH sub-framing support system in accordance with manufacturer's written installation instructions, and in compliance with system orientations, sizes, and locations as indicated on drawings.

B. Install continuous insulation system without gaps or voids, provide insulation fill-in at necessary locations, and do not compress insulation panels.

C. Trim insulation neatly to tightly fit spaces within plane of continuous insulation.

D. Exterior wall continuous insulation is not intended to be left exposed for extended periods of time; protect exposed insulation from open flame.

3.04 TOLERANCES

A. Shim and align CMH sub-framing support system with installation tolerances of 1/4 inch in 20 feet, non-cumulative, level, plumb, and aligned with locations as indicated on drawings.

3.05 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

B. Ensure that insulation panels are not exposed to moisture.

Remove wet insulation panels or allow them to completely dry prior to installation within CMH sub-framing support system.

C. Replace damaged insulation prior to Date of Substantial Completion.

END OF SECTION 070543.11

SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Modified bituminous sheet waterproofing.
2. Molded-sheet drainage panels.
3. Insulation drainage panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, inspection procedures, and protection and repairs.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and project specific details of substrate joints and cracks, expansion joints, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

C. Samples: For each exposed product and for each color and texture specified, including the following products:

1. 8-by-8-inch (200-by-200-mm) square of waterproofing and flashing sheet.
2. 4-by-4-inch (100-by-100-mm) square of drainage panel.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Research Reports: For modified bituminous sheet waterproofing/termite barrier, showing compliance with ICC AC380.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

E. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer. Installer shall have 5 years of experience in applying the same or similar materials and shall be specifically approved in writing by the membrane manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build for each typical waterproofing installation including accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

    a. Size: 100 sq. ft. (9.3 sq. m) in area.
    b. Description: Each type of wall installation.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.8 WARRANTY

A. Manufacturer's Warranty:

1. Waterproofing Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

a. Warranty Period: Five years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Waterproofing System: Obtain waterproofing materials and molded-sheet drainage panels from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING (WPG-1)

A. Modified Bituminous Sheet Waterproofing: Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Carlisle Coatings & Waterproofing Inc ; CCW MiraDRI 860/861 or a comparable product by one of the following:

a. GCP Applied Technologies Inc.
b. Henry Company.
c. Polyguard Products, Inc.
d. Soprema, Inc.
e. Tremco
f. W.R. Meadows, Inc.

2. Physical Properties:

a. Tensile Strength, Membrane: 250 psi (1.7 MPa) minimum; ASTM D412, Die C, modified.
b. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D1970/D1970M.
d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch (3-mm) movement; ASTM C836/C836M.
e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E154/E154M.
f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D570.

g. Water Vapor Permeance: 0.05 perm (2.9 ng/Pa x s x sq. m) maximum; ASTM E96/E96M, Water Method.
h. Hydrostatic-Head Resistance: 200 feet (60 m) minimum; ASTM D5385.

3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid primer recommended for substrate by sheet waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm), predrilled at 9-inch (229-mm) centers.

2.4 MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel without Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core, without a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft. (112 to 261 L/min. per m).

1. Basis-of-Design Product: Subject to compliance with requirements, provide Carlisle Coatings & Waterproofing Inc; CCW MiraDRAIN 6000 or a comparable product by one of the following:

a. GCP Applied Technologies Inc.
b. Polyguard Products, Inc.
c. Soprema, Inc.
d. W.R. Meadows, Inc.

2.5 INSULATION DRAINAGE PANELS

A. Insulation: Comply with Section 072100 "Thermal Insulation" for general building insulation.

B. Unfaced, Wall-Insulation Type VI, Drainage Panels: Extruded-polystyrene board insulation according to ASTM C578, Type VI, 40-psi (276-kPa) minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of waterproofing.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections.

E. Fill form tie holes, honeycomb, aggregate pockets, holes, and other voids.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D4258.

1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm).

G. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths according to manufacturer's written instructions.

1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.

H. Corners: Prepare, prime, and treat inside and outside corners in accordance with manufacturer's instructions.

1. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:

    a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.

I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Lap in the direction of the flow of water. Overlap and seal seams, and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 and 40 deg F (minus 4 and plus 5 deg C), install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F (16 deg C).

D. Two-Ply Application: Install sheets to form a membrane with lap widths not less than 50 percent of sheet widths, to provide a minimum of two thicknesses of sheet membrane over areas to receive waterproofing.

E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

F. Seal edges of sheet waterproofing terminations with mastic.

G. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing.

H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

I. Immediately install protection course with butted joints over waterproofing membrane.

1. Molded-sheet drainage panels may be used in place of a separate protection course to vertical applications when approved by waterproofing manufacturer and installed immediately.

3.4 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method

that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.5 INSTALLATION OF INSULATION DRAINAGE PANELS

A. Install insulation drainage panels over waterproofed surfaces. Cut and fit to within 3/4 inch (19 mm) of projections and penetrations.

B. Ensure that drainage channels are aligned and free of obstructions.

C. On vertical surfaces, set insulation drainage panels in adhesive or tape applied according to manufacturer's written instructions.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.

3.7 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071326

SECTION 071900 - WATER REPELLENTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Application of water repellents to protect:

1. Slab-on-grade, horizontal concrete surfaces.

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.03 SUBMITTALS

A. Product Data:

1. Submit manufacturer’s product data sheets for all products to be used. Include details on the protection of surrounding areas and non-masonry surfaces, surface preparation, application, and final cleaning procedures.

B. Applicator Qualifications: Submit qualifications of applicator.

1. An applicator that has at least 5 years of experience applying this scope of products.
2. A list of recently completed water repellent projects of similar scope, including project name, location, owner and architect names, a description of the products used, substrates, applicable local environmental regulations, and application procedures.

C. Environmental Regulations:

1. Submit applicable local environmental regulations.

D. VOC Certification:

1. Submit certification that water repellents furnished comply with local regulations controlling the use of VOC solvents.

1.03 TEST PANELS

A. Before beginning full-scale application, review the manufacturer's product data sheets to confirm the suitability of each product for specific surfaces and conduct mock-ups to determine compatibility and the desired final result.

B. Apply water repellents to test panels following the manufacturer's written instructions. Allow sufficient time for curing before evaluating the final appearance and results. Note that some products may require up to 10 days to fully develop long-term repellency. Full-scale application should not commence until the test panels are inspected and approved by the Architect.

C. Test Panel Requirements:

1. Size: Minimum 100 square feet each.
2. Locations: As determined by the Architect.

3. Number: Sufficient quantity to fully test each water repellent on each type of substrate to be protected.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers.

B. Store containers upright in a cool, dry, and well-ventilated area, away from direct sunlight. Keep containers separated from other chemicals and potential contaminants. Ensure that containers are tightly closed when not in use. Store and handle materials in accordance with the manufacturer's written instructions.

C. All containers must be clearly labeled with the product name and manufacturer's information.

1.05 PROJECT CONDITIONS

A. Temperature Limitations:

1. Do not apply when product, and/or surface temperature is below 40°F (4°C) or above 100°F (38°C).
2. Do not apply when surface and air temperatures are not expected to remain above 40°F (4°C) for a minimum of 8 hours after application, unless otherwise indicated by manufacturer's written instructions.

B. Wind Conditions:

1. Do not apply under windy conditions that may cause uncontrolled or excessive water repellent drift.

C. Frozen Substrates:

1. Do not apply to a frozen substrate. Allow sufficient time for the substrate to thaw if freezing conditions exist prior to application.

D. Rain Conditions:

1. Do not apply earlier than 24 hours after rainfall or if rain is predicted for up to 8 hours after application, unless otherwise specified in the manufacturer’s written instructions.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. LATICRETE International, Inc. No Substitutions.

2.02 WATER REPELLENTS (CS-1)

A. Horizontal Work: Silane-Siloxane Water Repellent: AQUAPEL is a clear, penetrating, VOC-compliant silane/siloxane blend designed to repel water and protect concrete surfaces from moisture and chloride-ion (salt) ingress. Offers protection against moisture intrusion and resists efflorescence, leaching, mildew staining, atmospheric staining, and freeze-thaw spalling. In addition, treated concrete surfaces are resistant to alkalis and acid rain.

1. Active Substance: Silane-siloxane
2. Total active solids: 10%
3. Color: Sprays white, dries clear
4. VOC: less than <10 grams per liter

PART 3 – EXECUTION

3.01 EXAMINATION

A. Surface Verification: Examine concrete surfaces to ensure they are suitable for the application of the specified water repellents. Notify the General Contractor if the surfaces are found to be unsuitable for product application.

3.02 PROTECTION

A. Protect surrounding areas, landscaping, building occupants, pedestrians, vehicles, and non-masonry surfaces from contact with water repellents, masonry or concrete cleaners (if used), residues, rinse water, fumes, wastes, and effluents during the work. Ensure all protection measures are in accordance with the manufacturer’s written instructions.

3.03 SURFACE PREPARATION

A. Clean all dirt, dust, oil, grease, curing compounds, and other contaminants from surfaces that may interfere with the penetration or performance of the water repellents. Use appropriate concrete cleaners approved by the water repellent manufacturer, as needed. Rinse thoroughly with a pressure water spray to remove any cleaner residues. Allow surfaces to dry completely before applying the water repellents.

B. Repair, patch, and fill all cracks, voids, defects, and damaged areas in the surface as approved by the Architect. Allow all repair materials to be fully cured before applying the water repellents.

C. Apply specified sealants and caulking and allow to cure completely before application of water repellents.

D. Seal all open joints.

E. Allow new concrete construction to cure for a minimum of 14 days before application of water repellents.

3.04 APPLICATION

A. Apply water repellents to substrates in accordance with manufacturer's written instructions, environmental regulations, and application procedures determined from test panel results approved by the Architect.

B. Apply to clean, dry, cure, and properly prepared surfaces approved by the Architect.

C. Do not dilute or alter water repellents. Apply directly from container.

3.05 FIELD QUALITY CONTROL

A. Inspection: Conduct an inspection of the water repellent work with the Contractor, Architect, applicator, and LATICRETE L&M Construction Chemicals, Inc. representative. Compare the work to the test panel results approved by the Architect and assess whether the substrates are adequately protected by the water repellents.

B. Manufacturer's Field Services: Provide the services of an authorized field representative from the manufacturer to verify that the specified products are used correctly. Ensure that protection, surface preparation, and application of the water repellents comply with the manufacturer’s written instructions and the test panel results approved by the Architect.

END OF SECTION 071900

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Mineral-wool blanket insulation.

B. Related Requirements:

1. Section 071326 "Self-Adhering Sheet Waterproofing" for insulated drainage panels.
2. Section 075419 "Polyvinyl-Chloride (PVC) Roofing" for insulation specified as part of roofing construction.
3. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic board insulation.
2. Polyisocyanurate foam-plastic board insulation.
3. Glass-fiber blanket insulation.
4. Mineral-wool blanket insulation.

B. Manufacturer’s installation instructions.

1.4 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For foam-plastic insulation, from ICC-ES.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (INSUL-1)

A. Extruded Polystyrene Board Insulation, Type IV: ASTM C578, Type IV, 25-psi (173-kPa) minimum compressive strength; unfaced. Perimeter Foundation Insulation.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DiversiFoam Products.
b. DuPont de Nemours, Inc.
c. Owens Corning.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
5. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION (INSUL-15)

A. Polyisocyanurate Board Insulation, Glass-Fiber-Mat Faced: ASTM C1289, glass-fiber-mat faced, Type II, Class 2, Grade 3.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Carlisle Coatings & Waterproofing, Inc.; R2+ MATTE Coated-Glass-Faced Polyiso Insulation or comparable product by one of the following:

a. Atlas Polyiso Roof and Wall Insulation.

b. Elevate; Holcim Building Envelope.
c. Hunter Panels; a Carlisle company.
d. Johns Manville; a Berkshire Hathaway company.
e. Rmax, A Business Unit of Sika Corporation.

2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
3. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.3 GLASS-FIBER BLANKET INSULATION (INSUL-40)

A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Certainteed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Owens Corning.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

2.4 MINERAL-WOOL BLANKET INSULATION (INSUL-60)

A. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. ROCKWOOL.
c. Thermafiber Inc.; an Owens Corning company.

2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
4. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.

B. Mineral-Wool Blanket Insulation, Reinforced-Foil Faced: ASTM C665, Type III (reflective faced); Class A, faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene with a formed 0.063-inch thick minimum (or as engineered for span and wind load) aluminum backpan with insulation adhered to inner surface of pan. Pan shall be formed to fit curtain wall opening and glazed into outer glazing channel behind 1-inch thick insulated glass as indicated on Drawings. Maintain a minimum of 2-inches from back face of glass and face of insulation. Flanges of pan shall be lapped, sealed with sealant and riveted to form interior moisture retarder, conforming to following:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Thermafiber, Inc.; an Owens Corning company; FireSpan 40 or comparable product by one of the following:

    a. Rockwool International; Curtainrock 40.
    b. Johns Manville; a Berkshire Hathaway company.

2. Density: 4 pcf.
3. Thickness: 2-inch, unless otherwise indicated.
4. R-Value: 15 at 4-inches (U-Value 0.06).
5. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
6. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.
7. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches (305 mm) and wider in width.
8. Fiber Color: Dark color, unless otherwise indicated.

2.5 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Spray Polyurethane Foam Insulation (INSUL-40): ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

1. Verify adhesives have a VOC content of 70 g/L or less.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF SLAB INSULATION

A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 36 inches (915 mm) in from exterior walls.

3.4 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Adhesive Installation: Install with adhesive according to manufacturer's written instructions.

3.5 INSTALLATION OF CAVITY-WALL INSULATION

A. Foam-Plastic Board Insulation: Install vertical beads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face and as recommended by manufacturer.

1. Fit courses of insulation between obstructions, with edges butted tightly in both directions, and with faces flush.
2. Press units firmly against inside substrates.
3. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Section 042000 "Unit Masonry."

3.6 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft. (40 kg/cu. m).
2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.7 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vapor-permeable, fluid-applied air barriers.

B. Related Requirements:

1. Section 061600 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

1.2 DEFINITIONS

A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.

B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.

C. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written instructions for evaluating, preparing, and treating each substrate and installation instructions; technical data; dry film thickness; and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air-barrier materials, accessories, and assemblies specific to Project conditions.
2. Include project specific details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction. Confirm compatibility with adjacent materials the air barrier will come into contact with such as waterproofing, roofing, etc.

3. Include details of interfaces with other materials that form part of air barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Include list of ABAA-certified installers and supervisors employed by Installer, who work on Project.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

D. Field quality-control reports.

A. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1. Installer to be licensed by ABAA according to ABAA's Quality Assurance Program and to employ ABAA-certified installers and supervisors on Project.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.

1. Build integrated mockups of each major exterior wall assembly type, 150 sq. ft. (14 sq. m), incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.

    a. Coordinate construction of mockups to permit inspection and testing of air barrier before external insulation and cladding are installed.
    b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
    c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove and replace liquid materials that cannot be applied within their stated shelf life.

B. Protect stored materials from direct sunlight.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended in writing by air-barrier manufacturer.

1. Protect substrates from environmental conditions that affect air-barrier performance.
2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.

B. VOC Content: 100 g/L or less.

2.2 PERFORMANCE REQUIREMENTS

A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E2357.

2.3 MEDIUM-BUILD AIR BARRIERS, VAPOR PERMEABLE (AB-1)

A. Medium-Build, Vapor-Permeable Air Barrier: Synthetic polymer material with an installed dry film thickness, according to manufacturer's written instructions, of 17 to 30 mils (0.4 to 0.8 mm) over smooth, void-free substrates.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Henry, a Carlisle Company; Air-Bloc All Weather STPE Air Barrier or a comparable product by one of the following:

a. Carlisle Coatings & Waterproofing, Inc.
b. GCP Applied Technologies Inc.
c. Tremco Incorporated.
d. W. R. Meadows, Inc.

2. Physical and Performance Properties:

   a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E2178.
   b. Vapor Permeance: Minimum 5 perms (290 ng/Pa x s x sq. m); ASTM E96/E96M, Procedure B, Water Method.
   c. Ultimate Elongation: Minimum 250 percent; ASTM D412, Die C.
   d. Adhesion to Substrate: Minimum 30 lbf/sq. in. (207 kPa) when tested according to ASTM D4541.
   e. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
   f. UV Resistance: Can be exposed to sunlight for 360 days according to manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

A. Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

B. Primer: Liquid primer recommended for substrate by air-barrier material manufacturer.

C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, 0.0187 inch (0.5 mm) thick, and Series 300 stainless steel fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

   1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
   2. Verify that substrates have cured and aged for minimum time recommended in writing by air-barrier manufacturer.
   3. Verify that substrates are visibly dry and free of moisture.
   4. Verify that masonry joints are flush and completely filled with mortar.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

H. Bridge isolation joints expansion joints and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.3 ACCESSORIES INSTALLATION

A. Install accessory materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.
3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.

B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

C. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

D. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

E. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.

F. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.

G. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

H. Seal top of through-wall flashings to air barrier with an additional 6-inch- (150-mm-) wide, transition strip.

I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.

3.4 PRIMARY AIR-BARRIER MATERIAL INSTALLATION

A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.

1. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
2. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
3. Where multiple prime coats are needed to achieve required bond, allow adequate drying time between coats.

B. Medium-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.

1. Vapor-Permeable, Medium-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, applied in one coat. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.

C. Do not cover air barrier until it has been tested and inspected by testing agency.

D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Air-barrier dry film thickness. Periodically measure wet mil thickness during membrane application and record the measurements for the project record.
3. Continuous structural support of air-barrier system has been provided.
4. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
5. Site conditions for application temperature and dryness of substrates have been maintained.
6. Maximum exposure time of materials to UV deterioration has not been exceeded.
7. Surfaces have been primed, if applicable.
8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
9. Termination mastic has been applied on cut edges.
10. Strips and transition strips have been firmly adhered to substrate.
11. Compatible materials have been used.
12. Transitions at changes in direction and structural support at gaps have been provided.
13. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
14. All penetrations have been sealed.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke tracers or ASTM E1186, chamber depressurization using detection liquids.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.
3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.

E. Air barriers will be considered defective if they do not pass tests and inspections.

1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
2. Remove and replace deficient air-barrier components for retesting as specified above.

F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

G. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than

recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials according to air-barrier manufacturer's written instructions.

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.

B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

C. Remove masking materials after installation.

END OF SECTION 072726

SECTION 074113.19 - BATTEN-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tee-top, seamed-batten metal roof panels.
2. Substrate board.
3. Vapor retarder.
4. Roof insulation.
5. Underlayment.

B. Related Requirements:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
2. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written installation instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of supporting structure during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal panel systems during and after installation.
9. Review procedures for repair of metal panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For batten-seam metal roof panels. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples for Initial Selection: Manufacturer's standard color charts, showing full range of available colors for each type of exposed finish.

1. Include similar Samples of trim and accessories involving color selection.

D. Samples for Verification: Actual sample of finished products for each type of exposed finish for metal panels, clips, fasteners, closures, and other metal panel accessories.

1. Size: Manufacturers' standard size.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For batten-seam metal roof panels, for tests performed by a qualified testing agency.

B. Field quality-control reports.

C. Qualification Statements: For roof installers.

D. Sample warranties.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels.

1.6 QUALITY ASSURANCE

A. Roof Installer Qualifications: Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Metal Panel Roof Systems Installers.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof area and eave, including fascia, and soffit as shown on Drawings; approximately 48 inches (1200 mm) square by full thickness, including attachments, underlayment, and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed in accordance with manufacturers' written installation instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.

b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer agrees to repair or replace batten-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested in accordance with ASTM E1680 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

C. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E1646 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

D. Watertightness: No water penetration when tested in accordance with ASTM E2140 for hydrostatic-head resistance.

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

G. Energy Performance:

1. Provide roof panels in accordance with one of the following when tested in accordance with CRRC-1:

a. Three-year, aged solar reflectance of not less than 0.49 and emissivity of not less than 0.87.
b. Three-year, aged Solar Reflectance Index (SRI) of not less than 56 when calculated in accordance with ASTM E1980.

2.2 BATTEN-SEAM METAL ROOF PANELS, GENERAL

A. Provide factory-formed metal roof panel assembly designed to be installed by mechanically attaching panels to supports using concealed clips and covering vertical side edges of adjacent panels with batten caps. Include caps and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

2.3 TEE-TOP, SEAMED-BATTEN METAL ROOF PANELS (MR-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Morin-A Kingspan Group Company; Symmetry Series SYM-12-0. No Substitutions.

B. Panels: Formed with vertical ribs at panel edges; designed for independent installation by mechanically attaching panels to supports using concealed clips located between panels, and mechanically seaming panel rib tops together to form tee-shaped joint.

1. Structural Support: Over solid deck.
2. Material: Metallic-coated steel. 20 ga.
3. Panel Profile: Flat pan.
4. Panel Coverage: 12 inches (305 mm).
5. Panel Height: 1.5 inches (38 mm).
6. Cap: Manufacturer's standard. Same material, finish, and color as roof panels.
7. Color: Copper Penny.
8. Clips: Single-piece floating to accommodate thermal movement.

a. Steel Clips: 0.064-inch- (1.63-mm-) nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
b. Clip Spacing: As indicated on approved Shop Drawings.

2.4 SUBSTRATE BOARD

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Certainteed; SAINT-GOBAIN; GlasRoc Sheathing Type X.
    b. Georgia-Pacific Gypsum LLC; Dens Deck Prime.
    c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
    d. USG Corporation; Securock Glass Mat Roof Board.

2. Thickness: Type X, 5/8 inch (16 mm).
3. Surface Finish: Factory primed.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions for fastening substrate panel to roof deck.

2.5 VAPOR RETARDER

A. Butyl Rubber Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

2.6 ROOF INSULATION

A. Insulation over Solid Deck:

1. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Atlas Polyiso Roof and Wall Insulation.
        2) Carlisle Syntec Systems.
        3) Elevate; Holcim Building Envelope.
        4) Hunter Panels; a Carlisle company.
        5) Johns Manville; a Berkshire Hathaway company.
        6) Rmax, A Business Unit of Sika Corporation.

    b. Compressive Strength: 20 psi (138 kPa).
    c. Size: 48 by 96 inches (1219 by 2438 mm).
    d. Thickness:

        1) Base Layer: As indicated on Drawings.

2. Composite Polyisocyanurate Board Insulation (INSUL-80): ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other surface.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Hunter Panels; a Carlisle Company; H-Shield NB or comparable product by one of the following:

        1) Atlas Polyiso Roof and Wall Insulation.
        2) Carlisle Syntec Systems.

3) Elevate; Holcim Building Envelope.
4) Johns Manville; a Berkshire Hathaway company.
5) Rmax, A Business Unit of Sika Corporation.

b. Facer: Type V APA exterior grade 5-ply CDX plywood facer, 3/4 inch (19 mm) thick.
c. Size: 48 by 96 inches (1219 by 2438 mm).
d. Thickness: As indicated on Drawings.

2.7 UNDERLAYMENT

A. Self-Adhering, High-Temperature Underlayment (HTRU-1): Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.01 mm) thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Basis-of-Design Product: Exceptional Metals; Exceptional HT (High Temperature) Underlayment.

2. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (minus 29 deg C); ASTM D1970/D1970M.

2.8 PANEL MATERIALS

A. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: 22 ga.
2. Surface: Smooth, flat finish.

2.9 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, minimum ASTM A653/A653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure

strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters (GUT-1): Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness of 20 ga. Furnish gutter supports spaced a maximum of 30 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels. Color: Copper Penny.

E. Downspouts (DS-1): Formed from same material as roof panels. Fabricate in 10-ft.- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness of 20 ga. Finish downspouts to match gutters.

F. Panel Fasteners: Self-tapping screws designed to withstand design loads.

G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.10 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with manufacturer's recommendations.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.11 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Mica Fluoropolymer: Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages in accordance with ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches (610 mm) in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

    a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board in accordance with roofing system manufacturers' written installation instructions.

3.4 INSTALLATION OF VAPOR RETARDER

A. Loosely lay vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches (50 and 152 mm), respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
2. Continuously seal side and end laps with adhesive.

3.5 INSTALLATION OF ROOF INSULATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, in accordance with manufacturer's written installation instructions.

3.6 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.7 INSTALLATION OF BATTEN-SEAM METAL ROOF PANELS

A. Install metal panels in accordance with manufacturer's written instructions and approved Shop Drawings in orientation, sizes, and locations indicated on Drawings. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners in accordance with manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Batten-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each batten-seam joint at location, spacing, and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling fasteners.
2. Apply caps to metal roof panel seams, fully engaged to provide weathertight joints.
3. Watertight Installation:

    a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend by manufacturer as needed to make panels watertight.
    b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements and manufacturer's written installation instructions. Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 ft. (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

J. Pipe and Conduit Penetrations: Fasten and seal to metal roof panels as recommended by manufacturer.

3.8 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.10 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.19

SECTION 074213.13 - FORMED METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concealed-fastener, lap-seam metal wall panels.
2. Metal liner panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review of procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.3 ACTION SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

1. Concealed-fastener, lap-seam metal wall panels.
2. Metal liner panels.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

3. Manufacturer to review shop drawings before submitted to Architect.

C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.

1. Include Samples of trim and accessories involving color selection.

D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:

1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For concealed-fastener, lap-seam metal wall panels and metal liner panels, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

E. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal panel assembly as shown on Drawings, including corner, supports, attachments, and accessories.
2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

E. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 CONCEALED-FASTENER, LAP-SEAM METAL WALL PANELS

A. Provide factory-formed metal panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Flush-Profile, Concealed-Fastener Metal Wall Panels (MP-3 & MP-5): Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Morin-A Kingspan Group Company; Matrix Series MX-6 Wall Panels. No Substitutions.

2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Nominal Thickness: 20 ga.
    b. Exterior Finish: Two-coat fluoropolymer (MP-5), Mica fluoropolymer (MP-3).
    c. Color: Bristol Black (MP-5), Copper Penny (MP-3).

3. Panel Coverage: 12 inches (305 mm).
4. Panel Height: 1.5 inches (38 mm).

C. V-Groove-Profile, Concealed-Fastener Metal Wall Panels (MP-1 & MP-2): Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Morin-A Kingspan Group Company; Pulse Series P-1 (MP-1) & P-9 (MP-2) Wall Panels. No Substitutions.

2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Nominal Thickness: 20 ga.
    b. Exterior Finish: Mica fluoropolymer.
    c. Color: Copper Penny.

3. Panel Coverage: 12 inches (305 mm).
4. Panel Height: 1.5 inches (38 mm).

2.3 METAL LINER PANELS

A. Provide factory-formed metal liner panels designed for interior side walls and field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for a complete installation.

B. Metal Liner Panels (MP-4): Formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Morin-A Kingspan Group Company; Matrix Series MX-6 Wall Panels. No Substitutions.

2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

    a. Nominal Thickness: 18 ga.
    b. Exterior Finish: Two-coat fluoropolymer.
    c. Color: Dove Gray.

3. Panel Coverage: 12 inches (305 mm).

4. Seam Height: 1.5 inches (38 mm).

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF METAL PANELS

A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
3. Flash and seal panels with weather closures at perimeter of all openings.

E. Watertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Metal Liner Panels: Install panels on interior side of girts with flush appearance on the inside.

G. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

H. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Water-Spray Test: After installation, test area of assembly as directed by Architect for water penetration according to AAMA 501.2.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.5 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.13

SECTION 074293 - SOFFIT PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal soffit panels.

B. Related Requirements:

1. Section 074213.13 "Formed Metal Wall Panels" for lap-seam metal wall panels.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Metal soffit panels.

B. Product Data Submittals:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
3. Manufacturer to review shop drawings before submitted to Architect.

D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Sample Warranties: For special warranties.

D. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical roof eave, including fascia, and soffit as shown on Drawings; approximately four panels wide by full eave width, including attachments and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METAL SOFFIT PANELS

A. Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile of metal wall panels.

1. Finish: Match finish and color of metal wall panels.
2. Sealant: Factory applied within interlocking joint.

C. Flush-Profile Metal Soffit Panels (MP-5): Solid and Perforated panels formed with vertical panel edges and a flat pan between panel edges; with flush joint between panels.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Morin-A Kingspan Group Company; Matrix Series MX-6 Wall Panels. No Substitutions.

2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 20 ga.
b. Exterior Finish: Two-coat fluoropolymer.
c. Color: Bristol Black.

3. Panel Coverage: 12 inches (305 mm).
4. Panel Height: 1.5 inches (38 mm).
5. Provide 2 strips of perforated panels (10% openness).

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275) hot-dip galvanized coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads.

E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.4 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal soffit panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.

a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 INSTALLATION OF METAL SOFFIT PANELS

A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.

1. Apply panels and associated items true to line for neat and weathertight enclosure.
2. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.

E. Watertight Installation:

1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels and elsewhere as needed to make panels watertight.
2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling, and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074293

SECTION 075419 - POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Walkways.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.3 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.

8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

B. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Polyvinyl chloride (PVC) roofing system.
2. Accessory roofing materials.
3. Substrate board.
4. Vapor retarder.
5. Roof insulation.
6. Insulation accessories and cover board.
7. Walkways.
8. For insulation and roof system component fasteners, include copy of SPRI's Directory of Roof Assemblies listing.

B. Shop Drawings: Project specific. Include roof plans, sections, manufacturer’s installation instructions, project specific details, transitions to other systems that comprise the air and water control layers, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane terminations.
3. Flashing details at penetrations.
4. Tapered insulation thickness and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane.
6. Tie-in with air barrier.

C. Samples for Verification: For the following products:

1. Roof membrane and flashing, of color required.

2. Walkway pads or rolls, of color required.

D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of compliance with performance requirements.

2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field quality-control reports.

F. Sample Warranties: For manufacturer's special warranties.

G. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: A qualified manufacturer that is listed in SPRI's Directory of Roof Assemblies for roofing system identical to that used for this Project.
2. Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. Five years installation experience with specified roof system and specific manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Safety requirements:

1. All applications, material handling, and associated equipment shall conform to and be operated in conformance with OSHA safety requirements.
2. Comply with federal, state, local and owner fire and safety requirements
3. Advise owner when any work is expected to be hazardous to owner or employees
4. Maintain a crewman as a floor area guard whenever roof decking is being repaired or replaced.
5. Maintain fire extinguisher within easy access whenever power tools and torches are being used.

C. Environmental requirements:

1. Do not work in rain, snow, or in presence of water.
2. Do not work in temperatures below 40 F without permission from architect and roof manufacturer
3. Do not install materials marked “keep from freezing” when daily temperatures are scheduled to below 40 F.
4. Remove any work damaged by freezing
5. Advise the Owner when volatile materials are to be used near air ventilation intakes so that they can be shut down or blocked as owner requires.

1.10 WARRANTY

A. Special Manufacturer’s Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roof membrane, base flashings, roof insulation, adhesives, fasteners, cover boards, vapor retarders, substrate boards, copings, walkway products, fascias, cants, nailers, blocking, as well as all metal work and other components of roofing system.
2. Warranty Period: 20 years from date of Substantial Completion. No dollar limit.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashings, roof insulation, adhesives, fasteners, cover boards, substrate boards, vapor retarders, copings, walkway products, fascias, cants, nailers, blocking as well as any metal work, and other components of roofing system for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing and base flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

1. Accelerated Weathering: Roof membrane to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897. Refer to Structural Drawings for design criteria.

D. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.

E. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.2 POLYVINYL CHLORIDE (PVC) ROOFING SYSTEM (PVC-1)

A. PVC Sheet Type III: ASTM D4434/D4434M, fabric reinforced.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Duro-Last, Inc.; Duro-Tuff roof membrane.

2. Thickness: 60 mils (1.5 mm).
3. Exposed Face Color: White.

B. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

2.3 ACCESSORY ROOFING MATERIALS

A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Bonding Adhesive: Manufacturer's standard.

E. Low-Rise, Urethane, Fabric-Backed Membrane Adhesive: Roof system manufacturer's standard spray-applied, low-rise, two-component urethane adhesive formulated for compatibility and use with fabric-backed membrane roofing.

F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors an integral caulk ledge.

G. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

H. Miscellaneous Accessories: Provide manufacturer recommended preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 SUBSTRATE BOARD (RF BD-1)

A. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177/C1177M, water-resistant gypsum board.

1. Basis-of-Design Product: Duro-Last, Inc.; Duro-Guard DEXcell Glass Mat Roof Board.

2. Thickness: Type X, 5/8 inch (16 mm).

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR RETARDER (RVB-1)

A. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil (0.76-mm) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

1. Basis-of-Design Product: Duro-Last, Inc.; Vapor Barrier.

2.6 ROOF INSULATION (INSUL-70)

A. General: Preformed roof insulation boards manufactured or approved by PVC roof membrane manufacturer, approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

1. Basis-of-Design Product: Duro-Last, Inc.; Duro-Guard ISO II.

2. Compressive Strength: 20 psi (138 kPa).
3. Size: 48 by 48 inches (1219 by 1219 mm).
4. Thickness:

    a. Base Layer: 3-5/16 inches.
    b. Upper Layer: As indicated on Drawings.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch (6.35 mm).
3. Slope:

    a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.
    b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

2.7 INSULATION ACCESSORIES AND COVER BOARD

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. As recommended by Manufacturer.
2. Verify adhesives and sealants comply with the following limits for VOC content:

a. Plastic Foam Adhesives: 50 g/L.
b. Gypsum Board and Panel Adhesives: 50 g/L.
c. Multipurpose Construction Adhesives: 70 g/L.
d. Fiberglass Adhesives: 80 g/L.
e. Contact Adhesives: 80 g/L.
f. PVC Welding Compounds: 510 g/L.
g. Other Adhesives: 250 g/L.
h. Single-Ply Roof Membrane Sealants: 450 g/L.
i. Nonmembrane Roof Sealants: 300 g/L.
j. Sealant Primers for Nonporous Substrates: 250 g/L.
k. Sealant Primers for Porous Substrates: 775 g/L.

D. Glass-Mat Gypsum Cover Board (RF BD-2): ASTM C1177/C1177M, water-resistant gypsum board.

1. Basis-of-Design Product: Duro-Last, Inc.; Duro-Guard DEXcell FA Glass Mat Roof Board.

2. Thickness: 1/4 inch (6 mm).

2.8 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

1. Basis-of-Design Product: Duro-Last, Inc.; Roof Trak III Walkway Pad.

2. Size: Approximately 30 by 60 inches.
3. Color: As selected by Architect from manufacturer’s full range of color selections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, SPRI's Directory of Roof Assemblies listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 072726 "Fluid-Applied Membrane Air Barriers."

3.4 INSTALLATION OF SUBSTRATE BOARD

A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches (610 mm) in adjacent rows.

1. At steel roof decks, install substrate board at right angle to flutes of deck.

    a. Locate end joints over crests of steel roof deck.

2. Tightly butt substrate boards together.
3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
4. Fasten substrate board to top flanges of steel deck according to recommendations in SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29.
5. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.5 INSTALLATION OF VAPOR RETARDER

A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches (90 and 150 mm), respectively.

1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board and to marry with the roofing membrane if the materials are compatible.
2. Seal laps by rolling.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:

1. Install base layer of insulation with joints staggered not less than 24 inches (610 mm) in adjacent rows or end joints staggered not less than 12 inches (305 mm) in adjacent rows and with long joints continuous at right angle to flutes of decking. Stagger board joints in each direction.

    a. Locate end joints over crests of decking.
    b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).

        1) Trim insulation so that water flow is unrestricted.

    f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    h. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.

        1) Fasten insulation according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.
        2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.

    a. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.
    b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
    f. Trim insulation so that water flow is unrestricted.
    g. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    h. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    i. Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

        1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.7 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.

    a. Trim cover board so that water flow is unrestricted.

3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

    a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.8 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Start installation of roofing in presence of roofing system manufacturer's technical personnel Owner's testing and inspection agency.

D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roof membrane with side laps shingled with slope of roof deck where possible.

H. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

I. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.9 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars. Seal top of termination bar with sealant bead.

3.10 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.

1. Install flexible walkways at the following locations: As indicated on Drawings.
2. Provide 1-inch clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect. Perform welded seam testing regularly to evaluate the seam integrity such as at the beginning of each work day, after substantial pauses in installation activities, and if notable changes in weather occur.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.12 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.13 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: <Insert name of Owner>.
2. Owner Address: <Insert address>.
3. Building Name/Type: <Insert information>.
4. Building Address: <Insert address>.
5. Area of Work: <Insert information>.
6. Acceptance Date: _____.
7. Warranty Period: <Insert time>.
8. Expiration Date: _____.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and

expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding 74 mph;
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 075419

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Custom flashing and trim fabrications, made from the following:

1. Sheet metal materials.
2. Underlayment.
3. Miscellaneous materials.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 042200 "Concrete Unit Masonry" for materials and installation of manufactured sheet metal through-wall flashing and trim integral with masonry.
3. Section 074113.19 "Batten-Seam Metal Roof Panels" for materials and installation of sheet metal flashing and trim integral with roofing.
4. Section 074213.13 "Formed Metal Wall Panels" for sheet metal flashing and trim integral with metal wall panels.
5. Section 077200 "Roof Accessories" for roof hatches and other manufactured roof accessory units.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Plans, elevations, sections, and attachment details.
2. Fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Identification of material, thickness, weight, and finish for each item and location in Project.
4. Details for forming, including profiles, shapes, seams, and dimensions.
5. Details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.

6. Details of termination points and assemblies.
7. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Details of roof-penetration flashing.
9. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counterflashings.
10. Details of special conditions.
11. Details of connections to adjoining work.
12. Formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches (1:10).

C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long by actual width.

D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.

E. Samples for Verification: Actual sample of finished products for each type of exposed finish for sheet metal and other metal accessories.

1. Sheet Metal Flashing and Trim: Manufacturers' standard size. Include finished seam with required profile. Include fasteners, cleats, clips, closures, and other attachments.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates: For each type of coping and roof edge flashing that is ANSI/SPRI/FM 4435/ES-1 tested.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Research Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.

D. Qualification Statements: For fabricator.

E. Sample warranties.

F. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Entity that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Entity that employs a supervisor who is an NRCA ProCertified Roofing Foreman or installers who are NRCA ProCertified Architectural Metal Flashings and Accessories Installers.

C. For roof edge flashings and copings that are ANSI/SPRI/FM 4435/ES-1 tested, shop is to be listed as able to fabricate required details as tested and approved.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockup of typical roof edge, including gutter, fascia, approximately 10 ft. (3.0 m) long, including supporting construction cleats, seams, attachments, underlayment, and accessories.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.9 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, are to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim are not to rattle, leak, or loosen, and are to remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings and copings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METAL MATERIALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with minimum ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

1. Nominal Thickness: 20 ga. (typ), 18 ga. @ MP-4 panels.
2. Surface: Smooth, flat.
3. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

4. Color: As indicated on Drawings.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

C. Stainless Steel Sheet: ASTM A240/A240M, Type 316, dead soft, fully annealed.

1. Nominal Thickness: 20 ga.
2. Surface: Smooth, flat.
3. Exterior Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).

    a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

2.3 UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.01 mm) thick, specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer when recommended by underlayment manufacturer.

1. Basis-of-Design Product: Exceptional Metals; Exceptional HT (High Temperature) Underlayment.

2. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970/D1970M.
3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (minus 29 deg C) or lower; ASTM D1970/D1970M.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

    a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.

b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329/F2329M.

C. Solder:

1. For Stainless Steel: ASTM B32, Grade Sn96, with acid flux of type recommended by stainless steel sheet manufacturer.

D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.

E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

G. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

2.5 FABRICATION, GENERAL

A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters (GUT-2):

1. Basis-of-Design Product: Exceptional Metals; LX-Style Box Gutters.

2. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
3. Fabricate in minimum 96-inch- (2400-mm-) long sections.
4. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
5. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
6. Gutter Profile: As indicated on Drawings in accordance with cited sheet metal standard.
7. Accessories: Wire-ball downspout strainer.
8. Gutters: Fabricate from the following materials:

a. Aluminum-Zinc Alloy-Coated Steel: 24 ga. Matte Black.

B. Downspouts (DS-2): Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.

1. Basis-of-Design Product: Exceptional Metals; Closed-Face Downspouts with A-Style Elbow.

2. Manufactured Hanger Style: In accordance with SMACNA's "Architectural Sheet Metal Manual."
3. Fabricate from the following materials:

a. Aluminum-Zinc Alloy-Coated Steel: 24 ga. Matte Black.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12 ft.- (3.6 m) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, fasten and seal watertight. Shop fabricate interior and exterior corners.

1. Coping Profile: As indicated on Drawings in accordance with SMACNA's "Architectural Sheet Metal Manual."
2. Joint Style: Butted with expansion space and 6-inch- (150-mm-) wide, concealed backup plate.
3. Fabricate from the following materials:

a. Aluminum-Zinc Alloy-Coated Steel: 22 ga.

B. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Stainless Steel: 20 ga.

C. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:

1. Stainless Steel: 20 ga.

D. Flashing Receivers: Fabricate from the following materials:

1. Stainless Steel: 20 ga.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrates, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.

3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

3.3 INSTALLATION OF SHEET METAL FLASHING AND TRIM, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches (300 mm) o.c.
6. Space individual cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum andstainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 ft. (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
3. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.

1. Pretin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pretinning where pretinned surface would show in completed Work.
2. Do not solder metallic-coated steel and aluminum sheet.
3. Do not use torches for soldering.
4. Heat surfaces to receive solder, and flow solder into joint.

a. Fill joint completely.
b. Completely remove flux and spatter from exposed surfaces.

5. Stainless Steel Soldering:

a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
b. Promptly remove acid-flux residue from metal after tinning and soldering.
c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.

3.4 INSTALLATION OF ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with joints sealed with sealant.
2. Provide for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.
7. Anchor gutter with gutter brackets spaced not more than 24 inches (600 mm) apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.

8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 ft. (15.2 m) apart. Install expansion-joint caps.

C. Downspouts:

1. Join sections with 1-1/2-inch (38-mm) telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.
4. Provide elbows at base of downspout to direct water away from building.

3.5 INSTALLATION OF SLOPED ROOF SHEET METAL FABRICATIONS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Copings:

1. Install copings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches (100 mm) over base flashing.
3. Lap counterflashing joints minimum of 4 inches (100 mm).

3.6 INSTALLATION TOLERANCES

A. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 ft. (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 CLEANING

A. Clean off excess sealants.

3.8 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof hatches.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for ships' ladders for access to roof hatches.
2. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.

1. Include project specific plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work. Include manufacturer’s installation instructions.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Wind-Restraint Performance: As indicated on Drawings.

C. Comply with OSHA standards 1910.28(b)(3)(i) and 1910.28(b)(3)(iv).

2.2 ROOF HATCHES

A. Roof Hatches (RF H-1): Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kattsafe; Model No. KH3054 or a comparable product by one of the following:

    a. Activar Construction Products Group, Inc. - JL Industries.
    b. ACUDOR Products, Inc.
    c. Babcock-Davis.
    d. Bilco Company (The).
    e. Milcor; a division of Hart & Cooley, Inc.
    f. O'Keeffe's Inc.
    g. Pate Company (The).

B. Type and Size: Single-leaf lid, 30 by 54 inches (750 by 1370 mm).

C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.

D. Hatch Material: Zinc-coated (galvanized) steel sheet.

1. Thickness: 0.079 inch (2.01 mm).
2. Finish: Baked enamel or powder coat.
3. Color: White.

E. Construction:

1. Insulation: 1-inch- (25-mm-) thick, polyisocyanurate board.
2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
7. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is constant. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware: Spring operators, hold-open arm, galvanized steel spring latch with turn handles, galvanized steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

G. Safety Railing System (RF HG-1): Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

1. Basis-of-Design Product: Kattsafe; Model KG3054L.

2. Height: 42 inches (1060 mm) above finished roof deck.

3. Posts and Rails: Handrail: 2 in. round aluminum 6106-T6 tube, Harnass and Kneerail: 1-5/8 in round aluminum 6061-T6 tube.
4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches (533 mm) in diameter.
5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
8. Fabricate joints exposed to weather to be watertight.
9. Fasteners: Manufacturer's standard, finished to match railing system.
10. All hardware to be stainless steel.
11. Finish: Powder coated safety yellow.

2.3 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.

1. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils (0.05 mm).
2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).

B. Aluminum Extrusions and Tubes: ASTM B221 (ASTM B221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

C. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.

D. Underlayment:

1. Felt: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D4397.
3. Slip Sheet: Building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum, rosin sized.
4. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

G. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

H. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

I. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.

D. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Clean exposed surfaces according to manufacturer's written instructions.

C. Clean off excess sealants.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 077253 - SNOW GUARDS

- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Snow guards for metal roofs.
2. Non-penetrating attachment system.

1.2 RELATED SECTIONS

A. Section 074113.19 – Batten-Seam Metal Roof Panels.

B. Section 076200 – Sheet Metal Flashing and Trim.

1.3 REFERENCES

A. Aluminum Association (AA) - Aluminum Standards and Data, Current Edition.

B. ASTM International (ASTM):

1. A484/A484M-16 – Standard Specifications for General Requirements for Stainless Steel Bars, Billets and Forgings.
2. A554-16 – Standard Specification for Welded Stainless Steel Mechanical Tubing.
3. A555/A555M-16 – Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods.
4. B85-03 - Standard Specification for Aluminum-Alloy Die Castings.
5. B221-04a - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
6. F836M-02 (Current) – Standard Specification for Style 1 Stainless Steel Metric Nuts (Metric).
7. F880-12 – Standard Specification for Stainless Steel Socket, Square Head, Torx and Slotted Headless-Setscrews.

C. ICC Evaluation Service (www.icc-es.org):

1. Division: 050000 – METALS; Section: 050523 – METAL FASTENERS Evaluation Report ESR-3869.

1.4 SUBMITTALS

A. Action Submittal:

1. Shop Drawings: Include roof plans showing locations of snow guards on roof and attachment details and spacing.
2. Product Data:

a. Product description.
b. Construction details.

c. Material descriptions.
d. Individual component dimensions.
e. Finishes.
f. Installation instructions.

3. Samples:

a. Clamp samples.
b. 12-inch long cross member samples including all associated hardware.

B. Informational Submittals:

1. Proof of Job-Specific Engineering: Include registered professional engineer wet-stamped calculation for number and frequency of snow guard attachments based on design roof snow load, roof slope, roof dimensions, specific roof profile name, material type, gauge thickness and brand of manufacture; brand and model of snow retention device.
2. Proof of Product Testing: Results of appropriate product tensile load testing, issued by a recognized ISO 17025 accredited independent testing laboratory, showing the mean (of a minimum three test pulls) ultimate load-to-failure value of attachment clamping device proposed on the specimen material named in B.1.
3. Proof of Certified Production: Copy of manufacturer current ISO 9001 certficate (latest edition).
4. Proof of Best Practice Compliance: Manufacturer duly exected letter stating full compliance with all provisions of the Metal Construction Association technical bulletin, “Qualifying Snow Retention Systems for Metal Roofing” (latest edition).

C. Closeout Submittals:

1. Certification: Installer's certification or duly executed letter stating snow guard system was installed in accordance with manufacturer's instructions and approved shop drawings.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer to specialize in production of snow guard products of the type specified with a minimum of 10 years documented experience.

B. Manufactured in an ISO 9001 certified facility; ICC audited facility.

C. Installer Qualifications: Installer to specialize in metal roof installation and installation of snow guard products with a minimum of 5 years documented experience.

D. Mockup:

1. Size: Minimum 8 feet long.
2. Show: Snow guard attachment, cross members and accessories.
3. Locate where directed.
4. Approved mockup may remain as part of the Work.

E. Warranty:

1. Lifetime material/workmanship warranty on all products.

1.6 DELIVERY, STORGE AND HANDLING

A. Deliver components to jobsite properly packaged to provide protection during transport, delivery and handling.

B. Store products in manufacturer's original labeled and unopened packaging in a clean and dry location, protected from potential damage, until ready for application.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Attachment system to provide attachment to standing seam metal roofs:

1. With only minor dimpling of panel seams.
2. Without penetrations through roof seams or panels.
3. Without use of sealers or adhesives.
4. Without violation of roof warranty.

B. Performance Requirements: Provide snow guards to withstand exposure to the weather and environmental elements and resist design forces without failure due to defective material or manufacture.

1. Loading: See structural drawings for roof design snow loads.
2. Factor of Safety: Utilize a factor of safety ≥ 2 to determine allowable loads from ultimate tested clamp tensile mean load values.
3. Source Limitation: Provide snow guard system as designed and tested by the manufacturer as a complete system. Install all system components by the same manufacturer.

2.2 MANUFACTURER

A. Basis of Design: S-5! div. of Metal Roof Innovations, Ltd. or comparable product by one of the foolowing

1. Berger; a Division of OmniMax International, Inc.
2. LMCurbs.
3. Rocky Mountain Snow Guards Inc.

2.5 CONTINUOUS, 2 INCH (50.8 MM) PIPE-TYPE SNOW RETENTION SYSTEMS FOR STANDING SEAM METAL ROOFS (SN GD-1)

A. Basis of Design: X-Gard 1.0, manufactured by S-5! div. of Metal Roof Innovations, Ltd.

B. Components:

1.Clamps:

a. Manufactured from 6000-series aluminum extrusions conforming to ASTM B221 or aluminum castings conforming to ASTM B85 and to AA Aluminum Standards and Data.

1) Basis-of-Design Product: S-5!; S-5-T Clamp.
2) Setscrews: 300-series stainless steel, 18-8 alloy, 3/8 inch (9.525 mm) diameter, with round nose point.

2. Pipe Brackets:

a. Manufactured from 6000-series alloy and temper aluminum extrusions conforming to ASTM B221 and AA Aluminum Standards and Data or cast aluminum.

1) Model: X-Gard 1.0 Bracket for single pipe cross member.

3. Pipes (Cross Members):

a. Manufactured from 6000-series alloy and temper aluminum extrusions conforming to ASTM B221 and AA Aluminum Standards and Data.

1) Model: NEX 2.0 Pipe.

4. Pipe Connector (Splice):

a. Manufactured from 6000-series alloy and temper aluminum extrusions confirming to ASTM B221 and AA Aluminum Standards and Data.

1) Model: NEX 2.0 Splice.

5. Ice and Snow Clips:

a. Aluminum, minimum 3 inches (76.2 mm) wide. (Recommended on row closest to eave.)

1) Model: X-Clip II for standing seam heights 1 inch (25.4 mm) to 1.5 inches (38.1 mm).

C. Finish:

1. Powder coated all components in custom color to match metal roof panels.

PART 3- EXECUTION

3.1 EXAMINATION

A. Prior to beginning installation, verify:

1. Panel seaming is complete.
2. Panel attachment is sufficient to withstand loads applied by snow guard system.
3. Installation will not impeded roof drainage.

3.2 PREPARATION

A. Clean areas to receive attachments; remove loose and foreign matter that could interfere with installation or performance.

3.3 INSTALLATION

A. Install system in accordance with manufacturer's current instructions and approved Shop Drawings.

B. X-Gard Snow Retention System:

1. Place clamps at maximum 48 inches (1219.2 mm) on center or less as required by certified calculation.
2. Place clamps in straight, aligned rows using a string line.
3. Place both setscrews on same side of clamp.
4. Tighten setscrews to manufacturer's recommended torque. Test setscrew torque using calibrated torque wrench.

5. Slide pipe cross member thru X-Gard 1.0.
6. Attach X-Gard 1.0 and cross members to clamps; tighten bolts to manufacturer's recommended torque.
7. Install splice connectors at pipe cross member end joints.
8. Do not cantilever cross members more than 20 inches (508 mm) beyond last clamp at ends.
9. Apply end cap to each pipe.
10. Install one X-Clip III per panel between panel seams.
11. Secure one X-Clip III to pipe using 12-14 x 7/8 inch (22.225 mm) stainless steel self drilling screw (provided).

END OF SECTION 077253

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.

B. Related Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each penetration firestopping system, for tests performed by a qualified testing agency.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."

2) Intertek Group in its "Directory of Building Products."
3) FM Approvals in its "Approval Guide."

2.3 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. RectorSeal Firestop; a CSW Industrials Company.
d. Specified Technologies, Inc.
e. Tremco Incorporated.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:

a. Those within the cavity of a wall.
b. 4-inch (200-mm) or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.

3. W-Rating: Provide penetration firestopping systems with a Class 1 W-rating in accordance with UL 1479.

D. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

1. Verify sealant has a VOC content of 250 g/L or less.

E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.

4. Steel sleeves.

2.4 FILL MATERIALS

A. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

B. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

C. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

D. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

E. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.

F. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

G. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

H. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

J. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.

K. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814/UL 1479 for membrane penetrations or ASTM E1725/UL 1724 for thermal barrier and circuit integrity protection.

L. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.

M. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.

N. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.

O. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.

P. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch (13 mm) diameter.

Q. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 078443 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies and for wall identification.
2. Section 092216 "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."

B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.3 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
3. Provide firestop products that do not contain ethylene glycol.

B. Intumescent Gypsum Wall Framing Gaskets (Applied to Steel Tracks, Runners and Studs prior to Framing Installation): Provide products with fire, smoke, and acoustical ratings that allow movement up to 100 percent compression and/or extension in accordance with UL 2079 or ASTM E1966; have an L Rating less than 1 cfm/ft. (0.00115 cu. m/s x m) in accordance with UL 2079; and a minimum Sound Transmission Class (STC) rating of 56 in accordance with ASTM E90 or ASTM C919.

C. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. RectorSeal Firestop; a CSW Industrials Company.
d. Specified Technologies, Inc.
e. Tremco Incorporated.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

1. Verify sealant has a VOC content of 250 g/L or less.

2.4 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition occurs, such as the intersection of a gypsum wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

3.3 INSTALLATION

A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. (4.57 m) from end of wall and at intervals not exceeding 30 ft. (9.14 m).

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstaining silicone joint sealants.
2. Urethane joint sealants.
3. Mildew-resistant joint sealants.
4. Latex joint sealants.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Discussion topics shall include;

a. Schedule.
b. Sequence.
c. Coordination of trades.
d. Substrate review and acceptance.
e. Protection
f. Shop drawings and submittals.
g. Interface condition and details.
h. Environmental constraints.
i. Mockups.
j. Testing requirements.
k. Field quality control efforts.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Joint sealants.
2. Joint-sealant backing materials.

B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.

4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

B. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

C. Sample warranties.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturers' special warranties.

B. Installer's special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

5. Test Method: Test joint sealants in accordance with Method A or method B, Tail Procedure and Flap Procedure, in ASTM C1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

6. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, Contractor is responsible for retest until satisfactory adhesion is obtained.
7. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.9 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.10 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. VOC Content: Verify sealants and sealant primers comply with the following:

1. Architectural sealants have a VOC content of 250 g/L or less.
2. Sealants and sealant primers for nonporous substrates have a VOC content of 250 g/L or less.
3. Sealants and sealant primers for porous substrates have a VOC content of 775 g/L or less.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.; Silpruf NB.
b. Pecora Corporation; Pecora 864NST.
c. Sika Corporation; Sikasil WS-295.
d. The Dow Chemical Company; DOW CORNING 756 SMS BUILDING SEALANT.
e. Tremco Incorporated; Spectrem 3.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bostik; Arkema.
b. Master Builders Solutions.
c. Pecora Corporation.

d. Sherwin-Williams Company (The).
e. Sika Corporation.
f. Tremco Incorporated.

B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Master Builders Solutions.
b. Pecora Corporation.
c. Sherwin-Williams Company (The).

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.; SCS1700 Sanitary.
b. Pecora Corporation; Pecora 860.
c. The Dow Chemical Company; DOW CORNING 786 SILICONE SEALANT.
d. Tremco Incorporated; Tremsil 200.

2.6 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; AC-20.
b. Sherwin-Williams Company (The); 850A Siliconized Acrylic Latex Caulk.
c. Tremco Incorporated; Tremflex 834.

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

a. Metal.
b. Glass.
c. Porcelain enamel.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

a. Extent of Testing: Test completed and cured sealant joints as follows:

1) Perform 10 tests for the first 1000 ft. (300 m) of joint length for each kind of sealant and joint substrate.
2) Perform one test for each 1000 ft. (300 m) of joint length thereafter or one test per each floor per elevation.

b. Test Method: Test joint sealants in accordance with Method A or Method B, Tail Procedure and Flap Procedure, in ASTM C1521.

1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

c. Inspect tested joints and report on the following:

1) Whether sealants filled joint cavities and are free of voids.
2) Whether sealant dimensions and configurations comply with specified requirements.
3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Contractor is responsible for retesting of failed applications until test results prove sealants comply with indicated requirements.

C. Prepare test and inspection reports.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Exterior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

    a. Construction joints in cast-in-place concrete.
    b. Control and expansion joints in unit masonry.
    c. Joints between metal panels.
    d. Joints between different materials listed above.
    e. Perimeter joints between materials listed above and frames of doors, windows and louvers.
    f. Control and expansion joints in ceilings and other overhead surfaces.
    g. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors unless noted otherwise.

B. Interior joints in horizontal traffic surfaces:

1. Joint Locations:

    a. Isolation joints in cast-in-place concrete slabs.
    b. Control and expansion joints in tile flooring.
    c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Interior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

    a. Control and expansion joints on exposed interior surfaces of exterior walls.
    b. Tile control and expansion joints.
    c. Vertical joints on exposed surfaces of unit masonry concrete walls and partitions.
    d. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors, including custom colors.

D. Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement:

1. Joint Locations:

    a. Control joints on exposed interior surfaces of exterior walls.
    b. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
    c. Other joints as indicated on Drawings.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

E. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces:

1. Joint Locations:

    a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    b. Tile control and expansion joints where indicated.
    c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.

B. Related Sections:

1. Division 04 Section "Concrete Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section "Door Hardware".
3. Division 09 Sections "High-Performance Coatings" for field painting hollow metal doors and frames.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.

16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.

C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly and thermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

C. Field quality control reports.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.

1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:

1. CECO Door Products (C).
2. Curries Company (CU).

3. Pioneer Industries (PI).
4. Steelcraft (S).

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 HOLLOW METAL DOORS

A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.

1. Design: Flush panel.
2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 “Laminated Core”.

    a. Provide 22-gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
    b. Thermal properties to rate at a fully operable minimum U-Factor 0.37 and R-Value 2.7, including insulated door, thermal-break frame and threshold.
    c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.38 and R-Value 2.6, including insulated door, kerf type frame, and threshold.

3. Level/Model: Level 4 and Physical Performance Level A (Maximum-Duty), Minimum 14 gauge (0.067 inch - 1.7-mm) thick steel, Model 2.

4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.

    a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

3. Level/Model: Level 3 and Physical Performance Level A (Extra-Heavy Duty), Minimum 16 gauge (0.053-inch - 1.3-mm) thick steel, Model 2.
4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:

1. Curries Company (CU) - Honeycomb Core - 707 Series.
2. Curries Company (CU) - Energy Efficient - 777 Trio-E Series.

2.4 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16” positive thermal break and integral vinyl weatherstripping.

C. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet.
3. Manufacturers Basis of Design:

a. Curries Company (CU) - Mercury 3 Thermal Break TQ Series.

D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
3. Manufacturers Basis of Design:

a. CECO Door Products (C) - SU Series.
b. Curries Company (CU) - M Series.

E. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.7 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Doors:

1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.

2. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
3. Electrical Raceways: Provide hollow metal doors to receive electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through-wire transfer hardware or wiring harness specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware". Wire nut connections are not acceptable.

D. Hollow Metal Frames:

1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

    a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.

3. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
4. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
5. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
6. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; including but not limited to, electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".

    a. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
    b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
    c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section "Door Hardware".
    d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.

7. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
8. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on-center and as follows:

        1) Two anchors per jamb up to 60 inches high.
        2) Three anchors per jamb from 60 to 90 inches high.

3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.

9. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
10. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.

E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.8 STEEL FINISHES

A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

E. Verify tolerances against manufacturers installations instructions for tornado and hurricane storm shelter openings.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.

1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.
5. Install frames with removable stops located on secure side of opening.
6. Install door silencers in frames before grouting.
7. Remove temporary braces necessary for installation only after frames have been properly set and secured.
8. Fire-Rated Openings: Install frames in accordance with NFPA 80.
9. Floor Anchors: Secure with postinstalled expansion anchors.

    a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

10. Solidly pack mineral-fiber insulation inside frames.

11. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

3.5 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

END OF SECTION 081113

SECTION 083300 - ROLLING SERVICE DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Springless rolling service doors.

1.2 RELATED SECTIONS

A. Section 055000 - Metal Fabrications: Support framing and framed opening.

1.3 REFERENCES

A. ANSI/DASMA 108 - American National Standards Institute Standard Method For Testing Sectional Garage Doors And Rolling Doors: Determination Of Structural Performance Under Uniform Static Air Pressure Difference.

B. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element.

C. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

D. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

E. ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

F. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

G. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

I. NEMA MG 1 - Motors and Generators.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

A. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.5 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Details of construction and fabrication.
4. Installation instructions.

B. Shop Drawings: Include project specific detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, wiring connections and accessories. Include relationship with adjacent construction.

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and patterns.

E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

F. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security closures.

B. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 COORDINATION

A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1.10 WARRANTY

A. Warranty: Manufacturer's limited door and operator system, to be free from defects in materials and workmanship for 3 years or 500,000 cycles, whichever occurs first.

B. PowderGuard Finish:

1. PowderGuard Zinc Base Coat applied to guides and headplates plus PowderGuard Premium applied to slat, curtain, bottom bar, and brackets: Manufacturer's limited Zinc Finish warranty for 4 years.

PART 2 PRODUCTS

2.1 SPRINGLESS ROLLING SERVICE DOORS (CD-1 & CD-2)

A. Basis-of Design Product: Subject to compliance with requirements, provide Overhead Door Corporation; EverServe Model 625S Insulated Springless Rolling Service Doors with Stormtite perimeter seals. Due to performance and design requirements, there will be No Substitutions allowed.

1. Curtain: Interlocking roll-formed metal slats as specified with endlocks attached to each end of alternate slats to prevent lateral movement.

a. Flat Profile insulated type F-265i with 20 gauge back covering steel; for doors up to 20 feet wide fabricated of:

1) 20 gauge powder coated steel.

b. Insulation: Slat cavity shall be filled with CFC-free, foamed-in-place, polyurethane insulation.

2. Performance:

a. R-Value: 7.7, U-Value: 0.13.
b. Through Curtain Sound Rating: Sound Rating: STC-28 (STC-30+ with HZ noise generator) as per ASTM E 90.
c. Installed System Sound Rating: STC-21 as per ASTM E 90.
d. U-factor: 0.91 NFRC test report, maximum U-factor of no higher than 1.00.
e. Air Infiltration: Meets ASHRAE 90.1 & IECC 2012/2015 C402.4.3 Air leakage < 1.00 cfm/ft2.

3. Curtain and Hood Finish:

a. Galvanized Steel: Slats and hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester top coat.

1) Powder Coat:

(a) PowderGuard Premium powder coat color as selected by the Architect.

2) Non-galvanized exposed ferrous surfaces shall receive one coat

of rust-inhibitive primer.

4. Weatherseals:

   a. Vinyl bottom seal, exterior guide and internal hood seals.
   b. Interior guide weatherseal.
   c. Lintel weatherseal.

5. Bottom Bar: Two metal angles, minimum thickness 3/16 inch, bolted back to back to reinforce curtain in the guides.

   a. Material:
      1) Steel.

6. Guides: Three Structural steel angles provided with high usage guide wear strip to minimize wear and reduce sound.

   a. Material:

      1) Steel.

7. Brackets:

   a. Galvanized steel to support counterbalance, curtain and hood.

8. Finish; Bottom Bar, Hood and Brackets:

   a. PowderGuard Premium powder coat color as selected by the Architect.

9. Motor: Direct drive, integrated gear motor/brake assembly sized for openings. Provide with a manual hand chain for operation during power outages. Operator and drive assembly is factory pre-assembled and provided with all wiring harnesses needed direct from the factory.

   a. Supply Voltage: 200/240V AC, 1-phase, operating range 200/240V.

10. Control Panel: Electronic controller with microprocessor self-diagnostics. Digital readout indicates door action, alarm conditions and fault conditions. Time delay self-close timer and non-resettable cycle counter are included. Enclosure is IP54 rated (NEMA 3 equivalent). Provide auxiliary contacts for indicator lights that are to be mounted in the direction of travel. Flashing red lights for door rising and lowering. Continuous Green for door at full height.
11. Door Roll: Directly driven, springless roll shall be steel tube with integral shafts, keyed on the Drive End and supported by self-aligning greaseable sealed bearings. Door shall not require any counterbalance device.
12. Hood: Protecting drive motor, barrel, chain, and sprocket from dirt and debris and extending between the support brackets. Provide with internal hood baffle weatherseal. Fabricated of:

    a. 20 gauge galvanized steel with intermediate supports as required.

13. Safety Devices: Provide door with following safety devices:

    a. Photoelectric sensors that cast an invisible beam across the door opening and reverses the downward motion of the door when an object enters the path of the beam.

b. Provide a 6' light curtain on both side of the door for expanded detection of vehicles and people.
c. Built-in (to motor assembly) brake mechanism eliminates uncontrolled curtain travel independent of other safeties.
d. Sensing Edge Protection.

1) Electric sensing edge.

14. Actuators:

a. One Open/Close/Stop push button station incorporated into Control Panel in the interior of the building.
b. Provide for input of magnetic vehicle detector mounted above grade in the direction of travel at the door. Magnetic detectors will match owners outdoor gate detectors used for egress. All detectors will be IP66 Rated.

15. Warning light.

a. LED type warning lights shall be included. LED are to be strip type that flash red during door operation up and down and hold green when door is open.
b. Lights will match owner's warning lights at 601 building.

16. Wind load: Design door assembly to withstand wind/suction load of 20 psf (958 Pa) in conformance with DASMA 108-2012 and as required by local codes without damage to door or assembly components.
17. Face-of-wall Mounted.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify opening sizes, tolerances and conditions are acceptable.

B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to

structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Division 26. Complete wiring from disconnect to unit components.

F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 079200.

G. Install perimeter trim and closures.

H. Instruct Owner's personnel in proper operating procedures and maintenance schedule.

3.4 OPERATION

A. Door are intended to operate from magnetic vehicle detection mounted above grade.

B. Door will open for a preset time coordinated with the owner. Door will then close if light curtain and photo eye allow.

C. Door edge sensor, photo electric sensor and light sensor will halt operation.

D. Door will have a light bar on the door from the direction of travel that flashes red while the door is in operation and holds green when the door is fully open.

3.5 ADJUSTING

A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.

B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.6 CLEANING

A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.

B. Remove labels and visible markings.

C. Touch-up, repair or replace damaged products before Substantial Completion.

3.7 PROTECTION

A. Protect installed products until completion of project.

END OF SECTION 083300

SECTION 084313 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum-framed storefront ribbon window systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed storefronts, showing the following:

a. Joinery, including concealed welds.
b. Anchorage.
c. Expansion provisions.
d. Glazing.
e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.

5. Flashing and drainage.

F. Delegated-Design Submittal: For aluminum-framed storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer and field testing agency.
2. For professional engineer's experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the state in which Project is located.

B. Energy Performance Certificates: For aluminum-framed storefronts, accessories, and components, from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed storefront.

C. Product Test Reports: For aluminum-framed storefronts, for tests performed by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranties: For special warranties.

G. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed storefronts to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.7 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design aluminum-framed storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m).
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (575 Pa).

G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 12 lbf/sq. ft. (575 Pa).
2. Maximum Water Leakage: In accordance with AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

H. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.39 Btu/sq. ft. x h x deg F as determined in accordance with NFRC 100.

2. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa) when tested in accordance with ASTM E283.

3. Condensation Resistance Factor (CRF):

a. Fixed Glazing and Framing Areas: CRF for the system of not less than 69 as determined in accordance with AAMA 1503.

I. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows.

1. Outdoor-Indoor Transmission Class: Minimum 29.

J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).
c. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

2.2 ALUMINUM-FRAMED STOREFRONT RIBBON WINDOW SYSTEMS (WW-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide YKK AP America Inc.; YWW 45 TU Aluminum Ribbon Window System or comparable product by one of the following:

1. EFCO Corporation
2. Kawneer Company, Inc.; Arconic Corporation
3. Oldcastle BuildingEnvelope (OBE); CRH Americas, Inc.

4. U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.

B. Source Limitations: Obtain all components of aluminum-framed storefront system, including framing and accessories, from single manufacturer.

C. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Exterior Framing Construction: Thermally broken.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Glazing Plane: Front.
4. Finish: Color anodic finish.
5. Fabrication Method: Field-fabricated stick system.
6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
7. Steel Reinforcement: As required by manufacturer.

D. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

E. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.3 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

2.4 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.5 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

E. Rigid PVC Filler.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.7 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 612, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Black.
2. Basis-of-Design: YKK AP; YK1N Black Anodized Plus.

2.8 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.4 ERECTION TOLERANCES

A. Install aluminum-framed storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:

a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).

4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed storefronts.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.

a. Perform a minimum of three tests in areas as directed by Architect.
b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

a. Perform a minimum of three tests in areas as directed by Architect.
b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.

3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft. (300 Pa), and shall not evidence water penetration.

C. Aluminum-framed storefronts will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 084313

SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glazed aluminum curtain wall systems:

   a. Conventionally glazed.
   b. Two-sided, structural-sealant-glazed.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
2. Section 084313 "Aluminum-Framed Storefronts" for storefront systems installed with glazed aluminum curtain-wall systems.
3. Section 088000 "Glazing" for curtain wall glazing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Discussion topics shall include;

   a. Schedule.
   b. Sequence.
   c. Coordination of trades.
   d. Substrate review and acceptance.
   e. Protection
   f. Shop drawings and submittals.
   g. Interface condition and details.
   h. Environmental constraints.
   i. Mockups.
   j. Testing requirements.
   k. Field quality control efforts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, most current version of the manufacturer’s installation instructions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For glazed aluminum curtain walls. Include project specific plans, elevations, sections, full-size details, and attachments to other work. Prepared by or under the supervision

of a qualified professional engineer licensed in the State of Ohio detailing fabrication and assembly of glazed aluminum curtain-wall systems.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
2. Include full-size isometric details of each type of vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers and adjacent construction.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch (300-mm) lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

F. Delegated-Design Submittal: For glazed aluminum curtain walls, including analysis data signed and sealed by the qualified professional engineer licensed in the State of Ohio responsible for their preparation.

G. Provide THERM: Two-Dimensional Building Heat-Transfer Modeling at interfaces with adjacent opaque walls, roofs or slabs. Frame temperatures shall be confirmed to be maintained above the dew point temperature during design conditions.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer and field testing agency.
2. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.

B. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components from manufacturer.

1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.

C. Product Test Reports: For glazed aluminum curtain walls, for tests indicated in “Performance Requirements” section and performed by a qualified testing agency. Test reports shall be project specific and performed within the past 2 years.

D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, in accordance with recommendations in ASTM C1401. Include periodic quality-control reports.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For special warranties.

H. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed curtain walls to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AGM) contractors and that employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Owner and Architect.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

D. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of structural-sealant-glazed curtain wall assemblies.

1.7 MOCKUPS

A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation. Mockups will also be used to evaluate system installation and integration with the surrounding materials/systems.

1. Build mockup of typical wall area as shown on Drawings.
2. Testing shall be performed on mockups in accordance with requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 WARRANTY

A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: 10 years from date of Substantial Completion.

B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed in the State of Ohio to design glazed aluminum curtain walls.

B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure, including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

a. Thermal stresses transferring to building structure.
b. Glass breakage.
c. Noise or vibration created by wind and thermal and structural movements.
d. Loosening or weakening of fasteners, attachments, and other components.
e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans of greater than 13 feet 6 inches (4.1 m).
2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch (3.2 mm).

a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.

3. Cantilever Deflection: Limited to 2l/175 at unsupported cantilevers.

E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).

G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).

2. Maximum Water Leakage: In accordance with AAMA 501.1 No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters or water that is drained to exterior.

H. Interstory Drift: Accommodate design displacement of adjacent stories indicated.

1. Design Displacement: As indicated on Drawings.
2. Test Performance: Complying with criteria for passing based on building occupancy type when tested in accordance with AAMA 501.4 at design displacement and 1.5 times the design displacement.

I. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor):

a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.46 Btu/sq. ft. x h x deg F (2.61 W/sq. m x K) as determined in accordance with NFRC 100.

2. Air Leakage:

a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa) when tested in accordance with ASTM E283.

3. Condensation Resistance Factor (CRF):

a. Fixed Glazing and Framing Areas: CRF for the system of not less than 65 frame, 64 glass as determined in accordance with AAMA 1503.

J. Noise Reduction: Test in accordance with ASTM E90, with ratings determined by ASTM E1332, as follows:

1. Outdoor-Indoor Transmission Class: Minimum 26.
2. Sound Transmission Class: Minimum 31.

K. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

L. Structural-Sealant Joints:

1. Designed to carry gravity loads of glazing.

M. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

2.2 SOURCE LIMITATIONS

A. Obtain all components of curtain-wall system and storefront system, including framing entrances and accessories, from single manufacturer.

2.3 GLAZED ALUMINUM CURTAIN WALL SYSTEMS (CW-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide YKK AP America Inc.; YCW 750 OG and YKK 750 SSG Aluminum Curtain Wall System or a comparable product by one of the following:

1. EFCO Corporation.
2. Kawneer Company, Inc.; Arconic Corporation
3. Oldcastle BuildingEnvelope (OBE); CRH Americas, Inc.
4. U.S. Aluminum; C.R. Laurence Co., Inc.; CRH Americas, Inc.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Construction: Thermally broken.
2. Glazing System: Retained mechanically with gaskets on four sides and Retained mechanically with gaskets on two sides and structural sealant on two sides.
3. Size: 2-1/2” X 7-1/2”.
4. Glazing Plane: Front.
5. Finish: Clear anodic finish.
6. System: Stick system.
7. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
8. Steel Reinforcement: As required by manufacturer.

C. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.

1. Include snap-on aluminum trim that conceals fasteners. Standard and custom sizes as indicated on Drawings.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

E. Insulated Spandrel Panels (MWP-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mapes Industries, Inc; Mapes-R Panels or approved equal.

2. Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length. Glazed into curtain wall system where indicated on Drawings.

    a. Overall Panel Thickness: 1 inch (25.4 mm).
    b. Exterior Skin: Aluminum.

        1) Thickness: Manufacturer's standard for finish and texture indicated.
        2) Finish: Standard Kynar. Color as selected by Architect from manufacturer’s full range.
        3) Texture: Smooth.
        4) Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.

    c. Interior Skin: Aluminum.

        1) Thickness: Manufacturer's standard for finish and texture indicated.
        2) Finish: Mill finish.
        3) Texture: Smooth.
        4) Backing Sheet: 1/8-inch- (3.2-mm-) thick, tempered hardboard.

    d. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
    e. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

        1) Flame-Spread Index: 25 or less.
        2) Smoke-Developed Index: 50 or less.

    f. Accessories:

        1) Recommended for use as an infill panel component in curtain wall systems. Related material to complete installation as recommended by the manufacturer.
        2) Seals against moisture intrusion as recommended by the manufacturer. Polyurethane and silicone based sealant with a 20 year life are recommended.

2.4 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: ASTM C509 or ASTM C864. Comply with Section 088000 "Glazing."

1. Color: Black.

C. Glazing Sealants: As recommended by manufacturer. Comply with Section 088000 "Glazing."

1. Verify sealant has a VOC content of 250 g/L or less.

D. Structural Glazing Sealants: ASTM C1184, chemically curing silicone formulation that is compatible with system components with which it comes into contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.

1. Basis-of-Design Product: The Dow Chemical Company; Dow Corning 795 or approved equal.
2. Color: Black.

E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes into contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.

1. Color: Match structural sealant.

2.5 MATERIALS

A. Sheet and Plate: ASTM B209 (ASTM B209M).

B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).

C. Structural Profiles: ASTM B308/B308M.

D. Steel Reinforcement:

1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.

E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

2.6 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Fabricate components to resist water penetration as follows:

1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

E. Curtain-Wall Framing: Fabricate components for assembly using manufacturer's standard assembly method.

F. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 612, AA-M12C22A41, Class I, 0.018 mm or thicker.

1. Basis-of-Design: YKK AP; YS1N Clear Anodized Plus.

2.9 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.

D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.

G. Seal joints watertight unless otherwise indicated. Overlap splice plates with continuous lines of sealant.

H. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
3. Curtain wall assemblies are to be protected during post-construction cleaning.

I. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

J. Install components plumb and true in alignment with established lines and grades.

3.3 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.4 INSTALLATION OF STRUCTURAL GLAZING

A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

B. Set glazing into framing in accordance with sealant manufacturer's and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.

C. Set glazing with proper orientation, so that coatings face exterior or interior as specified.

D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.

E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer's and framing manufacturer's written instructions and in compliance with local codes.

F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.

G. Allow structural sealant to cure in accordance with manufacturer's recommendations.

H. Clean and protect glass as indicated in Section 088000 "Glazing."

3.5 INSTALLATION OF WEATHERSEAL SEALANT

A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass, as recommended by sealant manufacturer.

B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

3.6 ERECTION TOLERANCES

A. Install glazed aluminum curtain walls to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6.35 mm in 12.2 m).
3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
    c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).

4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.6 m); 1/2 inch (12.7 mm) over total length.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.

C. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.

    a. Perform a minimum of three tests in areas as directed by Architect.
    b. Perform tests in each test area as directed by Architect. Perform at least three tests each, prior to 10, 35, and 70 percent completion. Any uncontrolled water infiltration into the interior of the system that is not drained to the exterior is considered a failure.

2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. (0.45 L/s per sq. m) at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).

    a. Perform a minimum of three tests in areas as directed by Architect.
    b. Perform tests in each test area as directed by Architect. Perform at least three tests, prior to 10, 35, and 70 percent completion.

3. Water Penetration: ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 10 lbf/sq. ft. (480 Pa), and shall not evidence water penetration. Any uncontrolled water infiltration into the interior of the system that is not drained to the exterior is considered a failure.

D. Structural-Sealant Adhesion: Test structural sealant in accordance with recommendations in ASTM C1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of six areas on each building facade.
2. Repair installation areas damaged by testing.

E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 CLEANING AND PROTECTION

A. Cleaning: Contractor shall clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance, and remove construction debris from project site. Legally dispose of debris.

B. Protection: Contractor shall protect the installed product's finish surfaces from damage during construction.

END OF SECTION 084413

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Automatic operators.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 28 Section “Access Control Hardware Devices”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
8. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.
    c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format.

Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.

1.5 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.7 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to

source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUTT HINGES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

   a. Two Hinges: For doors with heights up to 60 inches.
   b. Three Hinges: For doors with heights 61 to 90 inches.
   c. Four Hinges: For doors with heights 91 to 120 inches.
   d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

   a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
   b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

   a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.

b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.

5. Manufacturers:

a. Hager Companies (HA) - BB Series, 5-knuckle.
b. Ives (IV) - 5BB Series, 5-knuckle.
c. McKinney (MK) - TA/T4A Series, 5-knuckle.

2.2 POWER TRANSFER DEVICES

A. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

a. Pemko (PE) - EL-CEPT Series.
b. Securitron (SU) - EL-CEPT Series.
c. dormakaba BEST (ST) EPT-12C Series.

B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Manufacturers:

a. Hager Companies (HA) - Quick Connect.
b. McKinney (MK) - QC-C Series.
c. dormakaba BEST (ST) - WH Series.

2.3 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.

3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Rockwood (RO).
    c. Trimco (TC).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Pulls, where applicable, shall be provided with a 10” clearance from the finished floor on the push side to accommodate wheelchair accessibility.
5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets. When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
6. Manufacturers:

    a. Burns Manufacturing (BU).
    b. Rockwood (RO).
    c. Trimco (TC).

2.4 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy. Manufacturer shall be based in the United States of America.

1. Manufacturers:

    a. Sargent Manufacturing (SA).
    b. Match Existing, Field Verify.
    c. No Substitution.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.

6. Keyway: Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

2.5 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).
b. MMF Industries (MM).
c. Telkee (TK).

2.6 MORTISE LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Manufacturers:

a. Sargent Manufacturing (SA) - 8200 Series.
b. No Substitution.

2.7 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.

3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.8 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.
9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.

1. Electromechanical exit devices shall have the following functions and features:

    a. Universal Molex plug-in connectors that have standardized color-coded wiring and are field configurable in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
    b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
    c. Options to be available for request-to-exit or enter signaling, latchbolt and touchbar monitoring.
    d. Field configurable electrified trim to fail-safe or fail-secure that operates from 12-24VDC.
    e. Five-year limited warranty for electromechanical features.

2. Manufacturers:

    a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    b. Sargent Manufacturing (SA) - 80 Series.
    c. Von Duprin (VD) - 35A/98 XP Series.

2.9 SURFACE DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Heavy duty surface mounted door closers shall have a 30-year warranty.

2. Manufacturers:

    a. Corbin Russwin Hardware (RU) - DC6000 Series.
    b. LCN Closers (LC) - 4040 Series.

c. Norton Rixson (NO) - 7500 Series.
d. Sargent Manufacturing (SA) - 351 Series.

2.10 ELECTROHYDRAULIC DOOR OPERATORS

A. Electrohydraulic Door Operators (High Traffic): Provide ANSI/BHMA A156.19 Certified Products Directory (CPD) listed low energy operators that meet ANSI/BHMA A156.4 requirements and are UL listed for use on fire rated doors and UL10C certified that comply with requirements for the Americans with Disabilities Act (ADA). Operators shall be verified by GreenCircle to offer energy savings of 19% when compared to similar products to accommodate openings up 250 pounds and 48” wide.

1. Provide operators with features as follows:

a. Non-handed with push and pull side mounting.
b. Operates as mechanical surface closer during close cycles, when door is opened manually or if power is off.
c. Activation by push button, hands-free or radio frequency devices.
d. On board electronics to collect usage and cycle count data to facilitate preventative maintenance/diagnostics.
e. Two-year limited warranty.
f. Wi-Fi interface where the operator is a secure, password protected WiFi hot spot with no connection to building’s IT required.
    1) Simple setup with no app required.
    2) View status and make adjustments without removing the cover.
    3) Built-in logic to support single use restroom applications with no external relay boards, logic modules, position switches required.
g. Mounting backplate to simplify and speed up installation.

2. Operators shall have the following functionality:

a. Adjustable Hold Open: Amount of time a door will stay in the full open position after an activation.
b. Blow Open for Smoke Ventilation: Door opens when signal is received from alarm system allowing air or smoke to flow through opening. Door will stay open until signal from alarm system is stopped.
c. Infinite Hold Open: Door will hold open at set position until power is turned off.
d. Obstruction Detection: Door closes if it hits an obstruction while opening; door will reverse to open position if it hits an obstruction while closing. Door will stop once it hits an obstruction and will rest against the obstruction until removed.
e. Open Delay: Delays operator opening for locking hardware.
f. Overload Safety Shut-Off: After two minutes of receiving a door activation signal, inverter times out and door closes to prevent motor/inverter damage.
g. Presence Detector Input: Input for external sensor to detect presence at door open or close position only.
h. Push & Go: As the door is manually opened, the operator "senses" movement and opens door to the full-open position.
i. Selector Mode Switch: Off disables the signal inputs unless Blow Open is activated, on activates the signal inputs, hold open activates the unit (unless Blow Closed is activated) to the hold open position.
j. Vestibule Delay: When the wall switch is pressed, first door in vestibule will open. Second door will open once vestibule door delay has expired. Delay is adjustable.

3. Manufacturers:

   a. Gyrotech Nabco - GT500 Series.
   b. LCN (LC) - 4630/4640 Series.
   c. Norton Rixson (NO) - 6000 Series.

2.11 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

   a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:

   a. Burns Manufacturing (BU).
   b. Rockwood (RO).
   c. Trimco (TC).

2.12 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

   a. Burns Manufacturing (BU).
   b. Hager Companies (HA).
   c. Rockwood (RO).
   d. Trimco (TC).

2.13 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. National Guard Products (NG).
2. Pemko (PE).
3. Reese Enterprises, Inc. (RE).

2.14 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Sargent Manufacturing (SA) - 3280 Series.
b. Security Door Controls (SD) - DPS Series.
c. Securitron (SU) - DPS Series.

B. Switching Power Supplies: Provide power supplies with either single or dual voltage configurations at 12 or 24VDC. Power supplies shall have battery backup function with an integrated battery charging circuit and shall provide capability for power distribution, direct lock control and Fire Alarm Interface (FAI) through add on modules. Power supplies shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs.

1. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

2.15 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.16 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. SU - Securitron
3. RO - Rockwood
4. SA - SARGENT
5. RF - Rixson
6. NO - Norton
7. PE - Pemko
8. HD - HID
9. OT - Other

Hardware Sets

Set: 1.0

Doors: DBG1

Description: Exterior HM - Panic Egress x Access Control x Auto-Door

3	HW Hinge	T4A3386 (NRP)	US32D	MK
1	Electric Power Transfer	EL-CEPT	630	SU
1	Elec Rim Exit Device, EL/RX/LX/NL Pull	43 53 55 56 8804 FSW, 0 bitted, match Sargent keyway	US32D	SA
1	Automatic Opener	6061 (D)	689	NO
1	Gasketing	2891AS (head)		PE
2	Gasketing	290AS (jambs)		PE
1	Rain Guard	346C (frame width)		PE
1	Sweep x Drip	345CNB		PE
1	Threshold - 6" T-Break	253x3AFG		PE
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU
1	Auto-Door Switch	503 Jamb / Mullion Mount		NO
1	Auto-Door Switch	505 Wall Mount		NO
1	Power Supply	By Security Vendor		SU

Notes:
Entry by valid input at reader to retract latch or manual key override.
Push / Pull operation by electronic dogging of exit device by access control system.
Free egress at all times.
Auto door operator and switches must be integrated with electronic exit device.
Latch monitor in exit device to control exterior auto-door switch. Exterior switch is active only when latch is retracted / door is unlocked.
Interior auto-door switch is always active and will retract latch before opening for ADA egress.
Door position switch to monitor opening status. Exit device has RX option to signal egress.
Coordinate with electrical and security contractors.
or position switch to monitor opening status. Exit device has RX option to signal egress.
Coordinate with electrical and security contractors.

Set: 2.0

Doors: DBG3, DBW1

Description: Exterior HM - Panic Egress x Access Control x Closer w/ Stop

3	HW Hinge	T4A3386 (NRP)	US32D	MK
1	Electric Power Transfer	EL-CEPT	630	SU
1	Elec Rim Exit Device, EL/RX/NL Pull	43 55 56 8804 FSW, 0 bitted, match Sargent keyway	US32D	SA
1	Surface Closer	TB 351 CPS	EN	SA

1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Gasketing	2891AS (head)		PE
2	Gasketing	290AS (jambs)		PE
1	Rain Guard	346C (frame width)		PE
1	Sweep x Drip	345CNB		PE
1	Threshold - 6" T-Break	253x3AFG		PE
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU
1	Power Supply	By Security Vendor		SU

Notes: Install gasketing at head before installing door closer.

Door normally closed and locked. Free egress at all times.
Entry by valid input at reader to retract latch or key override.
Passage function as needed by timed unlock via access control system.
Door position switch to monitor opening status if required. Exit device has RX option to signal egress.
Coordinate with electrical and security contractors.

Set: 3.0

Doors: DBW2

Description: Exterior HM Pair - Access Control x Closer w/ Stop

6	HW Hinge	T4A3386 (NRP)	US32D	MK
1	Electric Power Transfer	EL-CEPT	630	SU
1	Auto Flush Bolt Set	2842/2942 (as req'd)	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Fail Secure Lock	RX 8271-xxV LNJ, 0 bitted, match Sargent keyway	US26D	SA
2	Surface Closer	TB 351 CPS	EN	SA
2	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Gasketing	2891AS (head)		PE
1	Gasketing	290AS (jambs)		PE
1	Rain Guard	346C (frame width)		PE
2	Sweep x Drip	345CNB		PE
1	Threshold - 6" T-Break	253x3AFG		PE
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU
1	Power Supply	By Security Vendor		SU
1	Metal Edge Astragal	By Door Manufacturer		OT

Notes:
Doors normally closed and locked. Free egress at all times.
Entry by valid input at reader to release lock lever or key override.
Door position switch to monitor opening status. Lock has RX option to signal egress.
Coordinate with electrical and security contractors.
Rain sweep notched for door frame. Brush sweeps to mount on interior side.

Set: 4.0

Doors: DBG4

Description: Panic Egress - Access Control Function x Closer w/ Stop - Fire Rated

2	HW Hinge	T4A3786 (NRP)	US26D	MK
1	Elec HW Hinge	T4A3786 QC	US26D	MK
1	Elec Rim Exit Device, EL/RX/NL Lever	43 55 56 8804 ETJ	US32D	SA
1	Surface Closer	TB 351 CPS	EN	SA
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Perimeter Gasketing	S88BL (head & jambs)		PE
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU
1	Power Supply	By Security Vendor		SU

Notes:
Door normally closed and locked. Free egress at all times
Entry by valid input at reader to release lever trim or key override.
Door position switch to monitor opening status if required. Exit device has RX option to signal egress.
Coordinate with electrical and security contractors.

Set: 5.0

Doors: DBG5, DBG6

Description: Access Control Function x Closer w/ Stop

2	HW Hinge	T4A3786 (NRP)	US26D	MK
1	Elec HW Hinge	T4A3786 QC	US26D	MK
1	Fail Secure Lock	RX 8271-xxV LNJ, 0 bitted, match Sargent keyway	US26D	SA
1	Surface Closer	TB 351 CPS	EN	SA
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU
1	Power Supply	By Security Vendor		SU

Notes:
Door normally closed and locked. Free egress at all times
Entry by valid input at reader to release lock lever or key override.
Door position switch to monitor opening status. Lock has RX option to signal egress.
Coordinate with electrical and security contractors.

Set: 6.0

Doors: DBG7

Description: Access Control Function x Overhead Stop

2	HW Hinge	T4A3786 (NRP)	US26D	MK
1	Elec HW Hinge	T4A3786 QC	US26D	MK
1	Fail Secure Lock	RX 8271-xxV LNJ, 0 bitted, match Sargent keyway	US26D	SA
1	Surf Overhead Stop	10-336	652	RF
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Power Supply	By Security Vendor		SU

Notes:
Entry by valid input at reader to release lever or key override. Free egress at all times.
Coordinate with electrical and security contractors.

Set: 7.0

Doors: DBW4, DBW5

Description: Exterior HM - Access Control x Closer w/ Stop

3	HW Hinge	T4A3386 (NRP)	US32D	MK
1	Electric Power Transfer	EL-CEPT	630	SU
1	Fail Secure Lock	RX 8271-xxV LNJ, 0 bitted, match Sargent keyway	US26D	SA
1	Surface Closer	TB 351 CPS	EN	SA
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Gasketing	2891AS (head)		PE
1	Gasketing	290AS (jambs)		PE
1	Rain Guard	346C (frame width)		PE
1	Sweep x Drip	345CNB		PE
1	Threshold - 6" T-Break	253x3AFG		PE
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU

1	Power Supply	By Security Vendor		SU

Notes:
Doors normally closed and locked. Free egress at all times.
Entry by valid input at reader to release lock lever or key override.
Door position switch to monitor opening status. Lock has RX option to signal egress.
Coordinate with electrical and security contractors.
Rain sweep notched for door frame. Brush sweeps to mount on interior side.

Set: 8.0

Doors: DBG2

Description: Exterior HM x Panels - Panic Egress x Access Control x Closer w/ Stop

1	Continuous Hinge	FM300WT50 8'0 CTP	630	MR
1	Electric Power Transfer	EL-CEPT	630	SU
1	Elec Rim Exit Device, EL/RX/NL Pull	31 43 55 56 8804 FSW x SPAR NC-E05, 0 bitted, match Sargent keyway	US32D	SA
1	Surface Closer	TB 351 CPS	EN	SA
1	Kick Plate	K1050 10" 4BE CSK	US32D	RO
1	Gasketing	2891AS (head)		PE
1	Gasketing	290AS (jambs)		PE
1	Rain Guard	346C (frame width)		PE
1	Sweep x Drip	345CNB		PE
1	Threshold - 6" T-Break	253x3AFG		PE
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
1	Position Switch	DPS-M-BK		SU
1	Power Supply	By Security Vendor		SU

Notes:
Install gasketing at head before installing door closer. Template door closer for use with wide throw hinges.

Door normally closed and locked. Free egress at all times.
Entry by valid input at reader to retract latch or key override.
Passage function as needed by timed unlock via access control system.
Door position switch to monitor opening status if required. Exit device has RX option to signal egress.
Coordinate with electrical and security contractors.

Set: 9.0

Doors: DBG8

Description: Access Control Function Pair

5	HW Hinge	T4A3786 (NRP)	US26D	MK
1	Elec HW Hinge	T4A3786 QC	US26D	MK

1	Auto Flush Bolt Set	2842/2942 (as req'd)	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Fail Secure Lock	RX 8271-xxV LNJ, 0 bitted, match Sargent keyway	US26D	SA
1	Surface Closer	TB 351 CPS	EN	SA
1	E-Lynx Harness (Frame)	QC-C3000P		MK
1	E-Lynx Harness (Door)	QC-C*** (length / type as req'd)		MK
1	Card Reader	HID MiniProx by Security Vendor	BLK	HD
2	Position Switch	DPS-M-BK		SU
1	Power Supply	By Security Vendor		SU
1	Metal Edge Astragal	By Door Manufacturer		OT

Notes:
Door normally closed and locked. Free egress at all times
Entry by valid input at reader to release lock lever or key override.
Door position switches to monitor opening status if required.
Coordinate with electrical and security contractors.
Door closer on active leaf only.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Insulating glass.
3. Glazing sealants.
4. Glazing tapes.
5. Miscellaneous glazing materials.

1.2 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters in accordance with ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.3 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include sealant manufacturer’s temperature and substrate requirements.

B. Glass Samples: For each type of the following products; 12 inches (300 mm) square. For insulating glass units, provide assemblies representative of units to be used in the finished work, including coatings, spacers, edge seals, and edge deletion. Include gaskets, setting blocks, shims, and other glazing accessories.

1. Insulating glass.
2. Spandrel glass.

C. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of adjoining framing system.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Delegated Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturers of fabricated glass units, glass testing agency, and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For fabricated glass and glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
2. Include the glass fabricator/manufacturer’s calculations for wind pressure and thermal stress showing that the specified probabilities of breakage are not exceeded.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

F. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.7 QUALITY ASSURANCE

A. Fabricated-Glass Manufacturer Qualifications: A qualified manufacturer of fabricated glass units who is approved and certified by primary glass manufacturer.

B. Installer Qualifications: A qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal

(AG&M) contractors and who employs glazing technicians certified under the Architectural Glass and Metal Technician (AGMT) certification program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Install glazing in mockups specified in Section 084413 "Glazed Aluminum Curtain Walls" to match glazing systems required for Project, including glazing methods.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials in accordance with manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.11 WARRANTY

A. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Heat-Soaked Tempered Glass: Manufacturer agrees to replace heat-soaked tempered glass units that spontaneously break due to nickel sulfide (NiS) inclusions at a rate exceeding 0.3 percent (3/1000) within specified warranty period. Coverage for any other cause is excluded.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cardinal Glass Industries.
2. Guardian Glass; SunGuard.
3. Pilkington North America.
4. Viracon, Inc.
5. Vitro Architectural Glass.

B. Source Limitations for Glass: Obtain coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: For each product and installation method, obtain from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings.

a. Wind Design Data: As indicated on Drawings.

2. Design Snow Loads: As indicated on Drawings.
3. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for glass installed vertically or not more than 15 degrees from the vertical plane and under wind action.

    a. Load Duration: 60 seconds or less.

4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
5. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

D. Safety Glazing: Where safety glazing is indicated or required by code, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. Performance requirements for glazing including, but not limited to, visible transmittance and sound requirements.
2. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
5. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
6. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. NGA Publications: "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

1. Minimum Glass Thickness for Exterior Lites: 6 mm.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Roller distortion or ripples shall run in the same direction for the entire job. Roller distortion, measured peak to valley, shall not exceed 0.003 inches in the central area for 1/4 inch or thicker glass, or 0.008 inches within 10.5 inches of the leading or trailing edge for 1/4 inch or thicker glass. Clear or low-iron glass ¼" to 3/8" thick without ceramic frit or ink, maximum + or – 100 mD (millidiopter) over 95% of the glass surface. Local bow shall not exceed 1/32 inch in 12 inches.
2. Heat Soak Testing: Unless manufacturer's standard procedures are more stringent, perform heat soak testing of all fully tempered glass lites by placing glass in an oven at temperatures of 550dF,+/-50dF for a two hour "Dwell Time" to reduce the potential for spontaneous breakage to 5 lites per 1000 (5/1000).

B. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated. Roller distortion or ripples shall run in the same direction for the entire job. Roller distortion, measured peak to valley, shall not exceed 0.003 inches in the central area for 1/4 inch or thicker glass, or 0.008 inches within 10.5 inches of the leading or trailing edge for 1/4 inch or thicker glass. Clear or low-iron glass ¼" to 3/8" thick without ceramic frit or ink, maximum + or – 100 mD (millidiopter) over 95% of the glass surface. Local bow shall not exceed 1/32 inch in 12 inches.

C. Low-E-Coated Vision Glass: ASTM C1376.

1. Coated products to be magnetically sputtered vacuum deposition (MSVD).
2. Edge Deletion – When low-e coatings are used within an insulating unit, coating shall be edge deleted to completely seal the coating within the unit.

    a. The edge deletion should be uniform in appearance (visually straight) and remove 95% of the coating.

D. Silicone-Coated Spandrel Glass: ASTM C1048, Type I, Condition C, Quality-Q3.

2.5 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with polyisobutylene and silicone primary and secondary sealants.
2. Perimeter Spacer: Manufacturer's standard black warm edge spacer material and construction.
3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from the following:

1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
3. Silicone complying with ASTM C 1115.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.7 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:

1. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:

1. Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks:

1. Type recommended in writing by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch- (3-mm-) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended in writing by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.7 INSULATING GLASS SCHEDULE

A. Low-E-Coated, Clear Insulating Glass Type GL-21T:

1. Basis-of-Design Product: Viracon, Inc.; VNE1-63.
2. Overall Unit Thickness: 1 inch (25 mm).
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Fully tempered float glass.
5. Interspace Content: Argon.
6. Indoor Lite: Fully tempered float glass.
7. Low-E Coating: Sputtered on second surface.
8. Winter Nighttime U-Factor: 0.25 maximum.
9. Summer Daytime U-Factor: 0.21 maximum.
10. Visible Light Transmittance: 62 percent minimum.
11. Solar Energy Transmittance: 24 percent.
12. U-V Transmittance: 5 percent.
13. Visible Light Reflectance Exterior: 10 percent.
14. Visible Light Reflectance Interior: 10 percent.
15. Solar Energy Reflectance: 37 percent.
16. Shading Coefficient: 0.32.
17. SGHC: 0.28 maximum.
18. Safety glazing required.

B. Silicone-Coated, Low-E, Insulating Spandrel Glass Type GL-41:

1. Basis-of-Design Product: Viracon, Inc.; VNE1-63.
2. Coating Color: Harmony Gray.
3. Overall Unit Thickness: 1 inch (25 mm).
4. Minimum Thickness of Each Glass Lite: 6 mm.
5. Outdoor Lite: Clear heat-strengthened float glass.

6. Interspace Content: Argon.
7. Indoor Lite: Clear heat-strengthened float glass.
8. Low-E Coating: Sputtered on second surface.
9. Opaque Coating Location: Fourth surface.
10. Winter Nighttime U-Factor: 0.25 maximum.
11. Summer Daytime U-Factor: 0.21 maximum.

END OF SECTION 088000

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Horizontal Deflection:

1. Typical Partitions: L/240 at 5 lb/sq ft (239 Pa) lateral load.
2. Partitions supporting all other Concentrated Loads: Provide delegated engineering to comply with L/360 at 10 lb/sq ft (479 Pa) lateral load.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
2. Protective Coating: ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.

1. Steel Studs and Tracks:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) JN Linrose.
2) MarinoWARE.
3) MBA Building Supplies.
4) MRI Steel Framing, LLC.
5) Telling Industries.
6) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: As indicated on Drawings.
c. Depth: As indicated on Drawings.

2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ClarkDietrich.
2) MarinoWARE.
3) MBA Building Supplies.
4) Steel Construction Systems.
5) Telling Industries.
6) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: 0.0190 inch (0.483 mm).
c. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Track System: ASTM C645 top track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.

3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) ClarkDietrich; MaxTrak Slotted Deflection Track.
        2) MarinoWARE.
        3) Metal-Lite.
        4) Steel Construction Systems; Steel-Con Slotted Leg Track System.
        5) Telling Industries; Vertical Slip Track.
        6) The Steel Network, Inc.; VertiClip SLD.

D. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

B. Related Requirements:

1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing that support gypsum board panels.
3. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.3 MOCKUPS

A. Build mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for the following:

a. Each level of gypsum board finish indicated for use in exposed locations.

2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X (GYP BD-1): ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation; Saint-Gobain North America.
b. Continental Building Products, LLC.
c. Georgia-Pacific Gypsum LLC.
d. National Gypsum Company.
e. USG Corporation.

2. Thickness: As indicated on Drawings.
3. Long Edges: Tapered.

B. Impact-Resistant Gypsum Board (GYP BD-2): ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CertainTeed Corporation; Saint-Gobain North America.
    b. Continental Building Products, LLC.
    c. Georgia-Pacific Gypsum LLC.
    d. National Gypsum Company.
    e. USG Corporation.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
4. Indentation: ASTM C1629/C1629M, meets or exceeds Level 1 requirements.
5. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
6. Hard-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements according to test in Annex A1.
7. Long Edges: Tapered.
8. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

C. Mold-Resistant Gypsum Board (GYP BD-3): ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CertainTeed Corporation; Saint-Gobain North America.
    b. Continental Building Products, LLC.
    c. Georgia-Pacific Gypsum LLC.
    d. National Gypsum Company.
    e. USG Corporation.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:

    a. Cornerbead.
    b. L-Bead: L-shaped; exposed long flange receives joint compound.
    c. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    d. Expansion (control) joint.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

D. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
b. Pecora Corporation.
c. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
d. USG Corporation; SHEETROCK Acoustical Sealant.

2. Verify sealant has a VOC content of 250 g/L or less.

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

C. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

D. Form control and expansion joints with space between edges of adjoining gypsum panels.

E. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: Vertical surfaces unless otherwise indicated.
2. Impact-Resistant Type: As indicated on Drawings.
3. Mold-Resistant Type: As indicated on Drawings.

B. Single-Layer Application:

1. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. L-Bead: Use where indicated on Drawings.
3. U-Bead: Use at exposed panel edges.

3.5 FINISHING OF GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Porcelain tile.
2. Tile backing panels.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.2 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. Face Size: Actual tile size, excluding spacer lugs.

C. Module Size: Actual tile size plus joint width indicated.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

D. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches (300 mm) square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory for each color and finish required.

4. Metal edge strips in 6-inch (150-mm) lengths.

E. Installation Instructions: Manufacturer's printed Technical Manual / Guidelines.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a Five-Star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
3. Installer employs only Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers for Project.

B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of each type of wall tile installation.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS (CTW-1, CTW-2)

A. Porcelain Tile Type:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: As indicated on Drawings.
4. Thickness: As indicated on Drawings.
5. Face: As indicated on Drawings.
6. Tile Color, Glaze, and Pattern: As indicated on Drawings.
7. Grout Color: As indicated on Drawings.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

a. Base: Cove. Size as indicated on Drawings.

2.4 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 or ASTM C1325, Type A, in maximum lengths available to minimize end-to-end butt joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. C-Cure; C-Cure Board 990.
b. Custom Building Products; WonderBoard® Lite Backerboard.
c. FinPan, Inc.; ProTEC Concrete Backer Board.
d. Georgia-Pacific Gypsum LLC.
e. National Gypsum Company.
f. USG Corporation; DUROCK Cement Board.

2. Thickness: As indicated on Drawings.

2.5 SETTING MATERIALS

A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bostik; Arkema.
b. Custom Building Products.
c. H.B. Fuller Construction Products Inc. / TEC.

d. Laticrete International, Inc.
e. MAPEI Corporation.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.6 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.

1. Basis-of-Design Product: Subject to compliance with requirements, provide MAPEI Corporation; Kerapoxy IEG CQ or a comparable product by one of the following:

a. Custom Building Products.
b. H.B. Fuller Construction Products Inc. / TEC.
c. LATICRETE SUPERCAP, LLC.

2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.

2.7 MISCELLANEOUS MATERIALS

A. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metal designed specifically for flooring applications; stainless steel, ASTM A276/A276M or ASTM A666, 300 Series exposed-edge material.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Schluter Systems L.P.

B. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.8 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CERAMIC TILE

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.

2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Porcelain Tile: As indicated on Drawings.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

3.3 INSTALLATION OF TILE BACKING PANELS

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.5 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For components with factory-applied finishes.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

B. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 450 or less.

2.3 ACOUSTICAL PANELS (ACT-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C. Classification: Provide panels as follows:

1. Type and Form: As indicated on Drawings.
2. Pattern: As indicated on Drawings.

D. Color: As indicated on Drawings.

E. Light Reflectance (LR): As indicated on Drawings.

F. Noise Reduction Coefficient (NRC): As indicated on Drawings.

G. Edge/Joint Detail: As indicated on Drawings.

H. Thickness: As indicated on Drawings.

I. Modular Size: As indicated on Drawings.

J. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.

1. High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C 635/C 635M.

C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel.
5. Cap Finish: Painted in color as selected from manufacturer's full range.

2.5 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch- (2.69-mm-) diameter wire.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
11. Light fixtures shall be supported from the building structure and not by the acoustical ceiling system.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

a. As indicated on reflected ceiling plans.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3 mm in 3.6 m), non-cumulative.

3.5 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Thermoplastic-rubber base.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches (300 mm) long.

C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

D. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Coordinate mockups in this Section with mockups specified in other Sections.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Install resilient products after other finishing operations, including painting, have been completed.

1.8 WARRANTY

A. Provide manufacturer’s warranty that resilient base will be free of manufacturing defects for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE (RB-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style and Location:

a. Style A, Straight.

C. Thickness: 0.125 inch (3.2 mm).

D. Height: As indicated on Drawings.

E. Lengths: Cut lengths 48 inches (1219 mm) long or coils in manufacturer's standard length.

F. Outside Corners: Job formed or preformed.

G. Inside Corners: Job formed or preformed.

H. Colors: As indicated on Drawings.

2.2 INSTALLATION MATERIALS

A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

1. Verify adhesives have a VOC content of 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

H. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.

    a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.

    a. Miter or cope corners to minimize open joints.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:

1. Remove adhesive and other blemishes from surfaces.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096513

SECTION 097720 – DECORATIVE FIBERGLASS REINFORCED WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Prefinished polyester glass reinforced plastic sheets and adhered to unfinished substrate indicated on Drawings.

1. PVC trim.

B. Products Not Furnished or Installed under This Section:

1. Gypsum substrate board.
2. Resilient Base.

1.2 RELATED SECTIONS

A. Section 092900 – Gypsum Board.

B. Section 092216 – Non-Structural Metal Framing

C. Section 099124 – Interior Painting.

D. Section 096513 - Resilient Base and Accessories.

1.3 SUBMITTALS

A. Product Data: Submit sufficient manufacturer's data to indicate compliance with these specifications, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

B. Shop Drawings: Submit elevations of each wall showing location of paneling and trim members with respect to all discontinuities in the wall elevation.

C. Selection Samples: Submit manufacturer’s standard color pattern selection samples representing manufacturer's full range of available colors and patterns.

D. Samples for Verification: Submit appropriate section of panel for each finish selected indicating the color, texture, and pattern required.

1. Submit complete with specified applied finish.
2. For selected patterns show complete pattern repeat.
3. Exposed Molding and Trim: Provide samples of each type, finish, and color.

E. Manufacturers Material Safety Data Sheets (MSDS) for adhesives, sealants and other pertinent materials prior to their delivery to the site.

1.4 QUALITY ASSURANCE

A. Conform to building code requirements for interior finish for smoke and flame spread requirements as tested in accordance with:

1. ASTM E 84 (Method of test for surface burning characteristics of Building Materials):

a. Wall Required Rating – Class A.

B. Sanitary Standards: System components and finishes to comply with:

1. United States Department of Agriculture (USDA) requirements for food preparation facilities, incidental contact.
2. Food and Drug Administration (FDA) 1999 Food Code 6-101.11.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials factory packaged on strong pallets.

B. Store panels and trim lying flat, under cover and protected from the elements. Allow panels to acclimate to room temperature (70°) for 48 hours prior to installation.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Building are to be fully enclosed prior to installation with sufficient heat (70°) and ventilation consistent with good working conditions for finish work

B. During installation and for not less than 48 hours before, maintain an ambient temperature and relative humidity within limits required by type of adhesive used and recommendation of adhesive manufacturer.

1. Provide ventilation to disperse fumes during application of adhesive as recommended by the adhesive manufacturer.

1.7 WARRANTY

A. Furnish one year guarantee against defects in material and workmanship.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Marlite or approved equal.

B. Product (WP-1):

1. Standard FRP

2.2 PANELS

A. Fiberglass reinforced thermosetting polyester resin panel sheets complying with ASTM D 5319.

1. Coating: Multi-layer print, primer and finish coats or applied over-layer.
2. Dimensions:

    a. Thickness – 0.090 “ (2.29mm) nominal
    b. Width - 4'-0” (1.22m) nominal
    c. Length – As indicated on the drawings.

3. Tolerance:

    a. Length and Width: +/-1/8 “ (3.175mm)
    b. Square - Not to exceed 1/8 “ for 8 foot (2.4m) panels or 5/32 “ (3.96mm) for 10 foot (2.4m) panels

B. Properties: Resistant to rot, corrosion, staining, denting, peeling, and splintering.

1. Flexural Strength - 1.0 x 10^4 psi per ASTM D 790. (7.0 kilogram-force/square millimeter)
2. Flexural Modulus - 3.1 x 10^5 psi per ASTM D 790. (217.9 kilogram-force/square millimeter)
3. Tensile Strength - 7.0 x 10^3 psi per ASTM D 638. (4.9 kilogram-force/square millimeter)
4. Tensile Modulus - 1.6 x 10^5 psi per ASTM D 638. (112.5 kilogram-force/square millimeter)
5. Water Absorption - 0.72% per ASTM D 570.
6. Barcol Hardness (scratch resistance) of 35 55 as per ASTM D 2583.
7. Izod Impact Strength of 72 ft. lbs./in ASTM D 256

C. Back Surface: Smooth. Imperfections which do not affect functional properties are not cause for rejection.

D. Front Finish: Pebbled.

E. Color: As indicated on Drawings

2.3 MOLDINGS

A. PVC Trim: Thin-wall semi-rigid extruded PVC.

B. Outside Corner Guard:

1. M 961 PVC Outside Corner Guard.

2.4 ACCESSORIES

A. Adhesive: Either of the following construction adhesives complying with ASTM C 557.

1. Marlite C-551 FRP Adhesive - Water- resistant, non-flammable adhesive.
2. Marlite C-375 Construction Adhesive - Flexible, water-resistant, solvent based adhesive, formulated for fast, easy application.

3. Titebond Advanced Polymer Panel Adhesive – VOC compliant, non-flammable, environmentally safe adhesive.

B. Sealant:

1. Marlite Brand - Color Match Sealant.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine backup surfaces to determine that corners are plumb and straight, surfaces are smooth, uniform, clean and free from foreign matter, nails countersunk, joints and cracks filled flush and smooth with the adjoining surface.

1. Verify that stud spacing does not exceed 24” (61cm) on-center.

B. Repair defects prior to installation.

1. Level wall surfaces to panel manufacturer’s requirements. Remove protrusions and fill indentations.

3.2 INSTALLATION

A. Comply with manufacturer's recommended procedures and installation sequence.

B. Cut sheets to meet supports allowing 1/8” (3 mm) clearance for every 8 foot (2.4m) of panel.

1. Cut and drill with carbide tipped saw blades or drill bits, or cut with shears.
2. Pre-drill fastener holes 1/8” (3mm) oversize with high speed drill bit.

a. Space at 8” (200mm) maximum on center at perimeter, approximately 1” from panel edge.
b. Space at in field in rows 16’ (40.64cm) on center, with fasteners spaced at 12” (30.48 cm) maximum on center.

C. Apply panels to board substrate, above base, vertically oriented with seams plumb and pattern aligned with adjoining panels.

1. Install panels with manufacturer's recommended gap for panel field and corner joints.

a. Adhesive trowel and application method to conform to adhesive manufacturer’s recommendations.
b. Drive fasteners for snug fit. Do not over-tighten.

D. Apply panel moldings to all panel edges using silicone sealant providing for required clearances.

1. All moldings must provide for a minimum 1/8 “ (3mm) of panel expansion at joints and edges, to insure proper installation.
2. Apply sealant to all moldings, channels and joints between the system and different materials to assure watertight installation.

3.3 CLEANING

A. Remove excess sealant from panels and moldings. Wipe panel down using a damp cloth and mild soap solution or cleaner.

B. Refer to manufacturer's specific cleaning recommendations Do not use abrasive cleaners.

END OF SECTION 097720

SECTION 099124 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on interior substrates.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming structural steel.
2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
3. Section 099600 "High-Performance Coatings" for tile-like coatings.

1.3 DEFINITIONS

A. MPI Gloss Level 1 (Flat): Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

E. MPI Gloss Level 5 (Semigloss): 35 to 70 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, according to ASTM D523.

G. MPI Gloss Level 7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D523.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site with Construction Manager, Contractor, painting subcontractor, a representative of each coating manufacturer and Architect to review specifications, scope of work, surfaces to be coated, colors and other requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.7 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.9 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Provide lighting levels of 80 foot candles measured at mid-height at substrate surface.

D. For odor control within building, provide sufficient ventilation to outdoor air prior to, during and after installation of materials specified herein. Comply with EPA and other applicable standards for indoor air quality.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. Pittsburgh Paints Company (The).
3. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. VOC Content: For field applications that are inside the weatherproofing system, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Rust-Preventive Coatings: 100 g/L.
5. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
6. Pretreatment Wash Primers: 420 g/L.

D. Colors: As indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Masonry (Clay and CMUs): 12 percent.
2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.
h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.

d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates (PT-5):

1. Epoxy System:

a. Semi-gloss Finish:

1) 1st Coat: S-W Loxon Block Surfacer, LX01W200 (50-100 sq ft/gal).
2) 2nd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46-Series.
3) 3rd Coat: S-W Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46-Series (4.0 mils wet, 1.5 mils dry per coat).

B. Gypsum Board (PT-3):

1. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC.

   1) S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils (0.102 mm) wet, 1.0 mils (0.025 mm) dry.

b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.

c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3).

   1) S-W ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series, at 4.0 mils (0.102 mm) wet, 1.7 mils (0.043 mm) dry, per coat.

END OF SECTION 099124

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming of structural steel with primers specified in this Section.
2. Section 099124 "Interior Painting" for general field painting.

1.3 DEFINITIONS

A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product indicated.

C. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

E. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system.

a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. Pittsburgh Paints Company (The).
3. Sherwin-Williams Company (The).

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: Match Architect's samples.

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMUs): 12 percent.
3. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm).
2. Abrasive blast clean surfaces to comply with SSPC-SP 7/NACE No. 4.

E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.

1. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) at 6 to 12 inches (150 to 300 mm).

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 7/NACE No. 4.
2. SSPC-SP 11.
3. SSPC-SP 6/NACE No. 3.
4. SSPC-SP 10/NACE No. 2.
5. SSPC-SP 5/NACE No. 1.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings. Allow to weather a minimum of 6 months prior to coating. Clean per SSPC-SP1 using detergent and water or a degreasing cleaner, then prime as required. When weathering is not possible or the surface has been treated with chromates or silicates, first Solvent Clean per SSPC-SP1 and apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP16 is necessary to remove these treatments. Prepared surface shall be checked for latent passivating agents using a copper sulfate solution. Repeat SSPC-SP 1 until all passivating agents have been completely removed. Sweep (Abrasive) Blasting per SSPC-SP16 to achieve a uniform anchor profile (1.0 to 2.0 mils). Galvanized surfaces must be clean, dry, and free of passivating agents and contaminants prior to application of coatings.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:

   a. Equipment, including panelboards and switch gear.
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. Plastic conduit.
   g. Tanks that do not have factory-applied final finishes.
   h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:

   a. Equipment, including panelboards.
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. Plastic conduit.
   g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Steel and Galvanized-Metal Substrates (PT-7, PT-8):

1. Polysiloxane System; Solvent Based:

a. Gloss Finish:

1) 1st Coat: S-W Macropoxy 646 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
2) 2nd Coat: S-W Sher-loxane 800, (5.0-7.0 mils wet, 4.0-6.0 mils dry per coat).

3.7 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates (PT-1):

1. Polysiloxane System; Solvent Based:

a. Gloss Finish:

1) 1st Coat: S-W Macropoxy 646 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
2) 2nd Coat: S-W Sher-loxane 800, (5.0-7.0 mils wet, 4.0-6.0 mils dry per coat).

B. CMU Substrates (PT-4):

1. Polysiloxane System; Solvent Based:

a. Gloss Finish:

1) 1st Coat: S-W Kem Cati-Coat HS Epoxy Filler/Sealer, B42-400 Series (14.0-28.0 mils wet, 10.0-20.0 mils dry per coat).
2) 2nd Coat: S-W Macropoxy 646 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
3) 3rd Coat: S-W Sher-loxane 800, (5.0-7.0 mils wet, 4.0-6.0 mils dry per coat).

C. Steel and Galvanized-Metal Substrates (PT-6):

1. Polysiloxane System; Solvent Based: (Complete field applied system-primer and topcoat):

a. Gloss Finish:

1) 1st Coat: S-W Macropoxy 646 Fast Cure Epoxy, B58 Series (7.0-13.5 mils wet, 5.0-10.0 mils dry per coat).
2) 2nd Coat: S-W Sher-loxane 800, (5.0-7.0 mils wet, 4.0-6.0 mils dry per coat).

2. Polysiloxane System; Solvent Based: (Fabricator applied zinc primer, field applied polysiloxane):

a. Gloss Finish:

1) 1st Coat: S-W Zinc Clad 4100, (4.0-7.0 mils wet, 3.0-5.0 mils dry per coat).
2) 2nd Coat: S-W Sher-loxane 800, (5.0-7.0 mils wet, 4.0-6.0 mils dry per coat).

D. Gypsum Board Substrates (PT-2):

1. Epoxy System:

a. Prime Coat: Primer sealer, latex, interior:

1) S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600, at 1.0 mils (0.025 mm) dry, per coat.

b. Intermediate Coat: Epoxy, gloss matching topcoat.
c. Topcoat: Epoxy, gloss:

1) S-W Macropoxy 646 Fast Cure, at 5.0 to 10 mils (0.127 to 0.254 mm) dry, per coat.

END OF SECTION 099600

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.

C. Samples: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

E. Delegated Design Submittal: For signs indicated in "Performance Requirements" Article.

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For special warranty.

C. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design sign structure and anchorage of dimensional character sign type(s) according to structural performance requirements.

B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.

1. Uniform Wind Load: As indicated on Drawings.
2. Concentrated Horizontal Load: As indicated on Drawings.
3. Other Design Load: As indicated on Drawings.
4. Uniform and concentrated loads need not be assumed to act concurrently.

C. Thermal Movements: For exterior dimensional characters, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 DIMENSIONAL CHARACTERS (SIGN-1, SIGN-2)

A. Fabricated Dimensional Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.

1. Manufacturer: Kessler Sign Company, 5804 Poe Ave., Dayton, OH 45414. Contact: Brian Fisher, brian@kesslersignco.com. No Substitutions.

2. Character Material: Sheet or plate aluminum.
3. Material Thickness: Manufacturer's standard for size and design of character.
4. Character Height: Varies, as indicated on Drawings.
5. Character Depth: 6-inches.
6. Finishes:

    a. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard.
    b. Color: Green-colored letter faces (Pantone #7481), silver colored edging.
    c. Overcoat: Manufacturer's standard baked-on clear coating.

7. Mounting: Manufacturer's standard for size and design of character.
8. Typeface: As indicated on Drawings.

2.3 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Sheet and Plate: ASTM B209 (ASTM B209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors.
2. For exterior exposure, furnish stainless steel devices unless otherwise indicated.
3. Sign Mounting Fasteners:

    a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of sign material, unless otherwise indicated.

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean

exposed welded and brazed connections of flux, and dress exposed and contact surfaces.

4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match Architect's sample color unless otherwise indicated.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101419

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.

C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.

1. Include representative Samples of available typestyles and graphic symbols.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Room-Identification Signs: Full-size Sample.
2. Full-size Samples, if approved, will be returned to Contractor for use in Project.

E. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

B. Manufacturer's Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS (SIGN-3, SIGN-4, SIGN-5, SIGN-6)

A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Basis-of-Design Product: Subject to compliance with requirements, provide SpeedPro; Brushed Aluminum Dibond – ADA Raised (1/32") Copy and Braille Signage. Facility Standard - No Substitutions.

a. Contact: Sean Hohenstein, Phone: (937) 387-6067.

2. Mounting: VHB Tape.
3. Text and Typeface: Accessible raised characters and Braille. Finish raised characters to be black to contrast with background color, and finish Braille to match background color.

2.3 SIGN MATERIALS

A. Aluminum Sheet and Plate: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.

C. Mounting Methods:

1. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
2. pe adhesive.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.16

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Custodial accessories.

1.2 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.3 ACTION SUBMITTALS

A. Product Data Submittals: For each product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.

B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

C. Delegated Design Submittals: For grab bars.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranties.

B. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, visible silver spoilage defects.
2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.

B. Toilet Tissue (Roll) Dispenser (TP DSP-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; Model No. B-3888 or comparable product by one of the following:

a. ASI-American Specialties, Inc.
b. Bradley Corporation
c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
3. Mounting: Recessed.
4. Operation: Noncontrol delivery with theft-resistant spindle.
5. Capacity: Designed for 4-1/2- or 5-inch- (114- or 127-mm-) diameter tissue rolls.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
7. Lockset: Tumbler type.

C. Paper Towel (Folded) Dispenser (PT DSP-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick

Washroom Equipment, Inc.; Model No. B-359033 or comparable product by one of the following:

a. ASI-American Specialties, Inc.
b. Bradley Corporation
c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Mounting: Recessed.
3. Minimum Capacity: 300 C-fold or 400 multifold towels.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Lockset: Tumbler type.

D. Soap Dispenser (SP DSP-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; Model No. B-2111 or comparable product by one of the following:

a. ASI-American Specialties, Inc.
b. Bradley Corporation
c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
3. Mounting: Vertically oriented, surface mounted.
4. Capacity: 40-fl oz.
5. Materials: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type.
7. Refill Indicator: Window type.

E. Grab Bar (GB-1 & GB-2):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; Model No. B-6806 or comparable product by one of the following:

a. ASI-American Specialties, Inc.
b. Bradley Corporation
c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.

a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.

4. OD: 1-1/2 inches (38 mm).
5. Configuration and Length: As indicated on Drawings.

F. Mirror Unit (MIR-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; Model No. B-2908 or comparable product by one of the following:

a. ASI-American Specialties, Inc.

b. Bradley Corporation
c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Frame: Stainless steel angle, 0.05 inch (1.3 mm) thick.

a. Corners: Welded and ground smooth.

3. Size: As indicated on Drawings.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

G. Hook (CH-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Rockwood Manufacturing Company; ASSA ABLOY; Model No. RM811 or comparable product by one of the following:

a. ASI-American Specialties, Inc.
b. Bobrick Washroom Equipment, Inc.
c. Bradley Corporation
d. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Description: Single-prong unit.
3. Mounting: Exposed.
4. Material and Finish: Satin chrome plated.

2.3 CUSTODIAL ACCESSORIES

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Custodial Mop and Broom Holder (MOP-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; Model No. B-223 x 24 or comparable product by one of the following:

a. ASI-American Specialties, Inc.
b. Bradley Corporation
c. Gamco Commercial Restroom Accessories; Bobrick Washroom Equipment, Inc.

2. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.4 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch- (0.8-mm-) minimum nominal thickness unless otherwise indicated.

B. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch- (0.9-mm-) minimum nominal thickness.

C. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 (Z180) hot-dip zinc coating.

D. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

E. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.

F. Mirrors: ASTM C1503, Mirror Glazing Quality, tempered clear-glass mirrors, nominal 6.0 mm thick.

2.5 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION 102800

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguisher.

2. Fire department key box.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers" for portable, hand-carried fire extinguishers accommodated by fire-protection cabinets

1.2 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire-protection cabinets, including, but not limited to, the following:

a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fire-protection cabinets.

1. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.

E. Manufacturer’s Certificates:

1. Certification from manufacturers that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
2. Provide certificates from manufacturer for each product required indicating that product complies with specified product requirements and is suitable for use indicated.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

PART 2 - PRODUCTS

2.1 FIRE-PROTECTION CABINET (FE CAB-1)

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis-of-Design Product: Subject to compliance with requirements, provide SafetyOne; Model No. HDOC-10-SS Heavy Duty Outdoor Surface Mounted Fire Extinguisher Cabinet or approved equal.

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Stainless steel sheet.

D. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.

E. Door Material: Stainless steel sheet.

F. Door Style: Solid opaque panel with frame.

G. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim,, permitting door to open 180 degrees.

H. Accessories:

1. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.

a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

1) Location: Applied to cabinet door.
2) Application Process: Decals.
3) Lettering Color: White.
4) Orientation: Vertical.

3. Provide weather resistive gasketing.

4. Provide sloped roof to facilitate drainage.

I. Materials:

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 316.

a. Finish: ASTM A480/A480M No. 4 directional satin finish.

2.2 FIRE DEPARTMENT KEY BOX (FDKB-1)

A. Basis-of-Design Product: Subject to compliance with requirements, provide Knox Company; KnoxBox 3200, Model 3262NC or approved equal.

1. Color: Black.
2. Mount Type: Surface Mount.
3. Tamper Switch Type: Security and/or Fire Alarm Panel.
4. Provide Public Safety Labels, Tag-Out Tamper Seals, Key Tags and Key Rings.
5. Install according to manufacturer’s written installation instructions.

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Miter corners and grind smooth.
3. Provide factory-drilled mounting holes.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames of one-piece construction with edges flanged.
2. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

3.2 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.
b. Badger Fire Protection; a Carrier company.
c. Buckeye Fire Equipment Company.
d. Fire-End & Croker Corporation.
e. Guardian Fire Equipment, Inc.
f. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
g. Kidde; Carrier Global Corporation.
h. Larsen's Manufacturing Company.
i. Nystrom, Inc.
j. Potter Roemer LLC; a Division of Morris Group International.

2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: Manufacturer's standard.
4. Handles and Levers: Stainless steel.
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
6. Color: Red.

B. Multipurpose Dry-Chemical Type in Steel Container (FE-1, FE-2): UL-rated, FE-1: 4-A:60-B:C, 10-lb (4.5-kg) FE-2: 2-A:20-B:C, 5-lb (2.3-kg), nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

C. Selection and Quantity: The selection and locations of fire extinguishers are subject to the review and approval of the Owner's Project Manager. Fire extinguishers in addition to those required by NFPA may be required by the Owner.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.
b. Badger Fire Protection; a Carrier company.
c. Buckeye Fire Equipment Company.
d. Fire-End & Croker Corporation.
e. Guardian Fire Equipment, Inc.
f. J. L. Industries, Inc.; Activar Construction Products Group, Inc.
g. Kidde; Carrier Global Corporation.
h. Larsen's Manufacturing Company.
i. Nystrom, Inc.
j. Potter Roemer LLC; a Division of Morris Group International.

2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Basis-of-Design Product for Bracket-Mounted Fire Extinguishers (SIGN-7): My Safety Sign; Model No. S-4648 Projecting V-Shape Acrylic Sign or approved equal.

2. Basis-of-Design Product for Fire Extinguisher Cabinets (SIGN-8): ADA Sign Factory; Model No. EP5057-Steel in steel/black color or approved equal. A federal ADA-compliant sign with tactile graphics and dome-shaped Grade 2 Braille made from durable, vandal-proof, high-impact CAD-cut acrylic.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 112424 – FALL PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: This Section specifies design, supply and installation of Fall Protection systems.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC).

1. AISC S342L 1993, Load and Resistance Factor Design Specification for Structural Steel Buildings (including Supplement No.1).

B. Aluminum Association (AA).

1. AA DAF 45, Designation System for Aluminum Finishes.
2. AA ADM-1 2000, Aluminum Design Manual.

C. American Society of Mechanical Engineers (AMSE).

1. ASME A120.1 2006, Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance.

D. American National Standards Institute / International Window Cleaning Association (ANSI/IWCA).

1. ANSI/IWCA I-14.1 2006, Window Cleaning Safety Standard.

E. American Welding Society (AWS).

1. AWS D1.2/D1.2M 2003, Structural Welding Code - Aluminum.
2. AWS D1.1/D1.1M 2006, Structural Welding Code—Steel.

F. ASTM International (ASTM).

1. ASTM A123/A123M 2002, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A167 1999 (2004), Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip.
3. ASTM A276 2006, Standard Specification for Stainless Steel Bars and Shapes.
4. ASTM A492 1995 (2004) Standard Specification for Stainless Steel Rope.
5. ASTM B221 2006, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

G. International Code Council (ICC).

1. International Building Code.

H. Occupational Safety and Health Administration (OSHA).

1. OSHA 1910, Subpart D, Walking and Work Surfaces.
2. OSHA 1910, Subpart F, Appendix C, Personal Fall Arrest Systems.
3. OSHA Ruling on Window Cleaning by Bosun’s Chair.

4. OSHA 1910.66 Subpart F, Powered Platforms.

1.03 ACTION SUBMITTALS

A. Shop Drawings: Project specific. Indicate information on shop drawings as follows:

1. Submit shop drawings showing complete layout and configuration of fall protection equipment including components and accessories.
2. Indicate design and fabrication details, hardware, and installation details.
3. Include installation and rigging instructions and:

   a. Required restrictive working usage and general safety notes.
   b. Non-restrictive working usage and general safety notes.

4. Ensure Shop Drawings are reviewed by Engineer licensed in State of Ohio and submit calculations and test reports to Architect.

B. Submit product data, including manufacturer’s technical data sheet, for specified products.

1.04 INFORMATION SUBMITTALS

A. Quality Assurance:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
2. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
3. Manufacturer’s installation instructions.

B. Manufacturer’s field reports specified.

1.05 CLOSEOUT SUBMITTALS

A. Submit 1-year standard manufacturer warranty documents specified.

B. Operation and Maintenance Data: Submit Operation and Maintenance data for installed products.

1. Include:

   a. Manufacturer’s instructions covering maintenance requirements and parts catalog giving complete list of repair and replacement parts with cuts and identifying numbers.
   b. 1 copy of system Equipment Manual & Inspection Log Book, with "Initial Inspection - Certification for Use" and "Inspection Sign-Off" forms completed.
   c. 2 copies of reduced, “as-built shop drawing” showing equipment locations and details. Ensure drawing is posted adjacent exits to roof.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
2. Manufacturer Qualifications: Manufacturer capable of providing field service representation during construction and approving application method.

B. Regulatory Requirements.

1. Comply with International Building Code (IBC) and Building Code for State of Ohio.
2. Comply with OSHA regulations as follows:

a. 1910, Subpart D, Walking and Working Surfaces.
b. Appendix C to 1910 Subpart F, Personal Fall Arrest Systems.

C. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.07 DELIVERY, STORAGE AND HANDLING

A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Delivery:

1. Deliver materials in manufacturer's original packaging with identification labels intact and in sizes to suit project.

C. Storage and Protection:

1. Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

1.08 PROJECT AMBIENT CONDITIONS

A. Installation Location: Assemble and erect components only when temperatures are above 40 degrees F (4 degrees C).

1.09 SEQUENCING

A. Sequence with other Work and comply with equipment manufacturer's written recommendations for sequencing construction operations.

1.10 WARRANTY

A. Project Warranty: Refer to Contract Conditions for additional project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and does not limit, other rights Owner may have under Contract Documents.

C. Warranty: Commencing on date of substantial completion set by Architect.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Ensure manufacturer has minimum 10 years experience in manufacturing fall protection and suspended maintenance system components similar to or exceeding requirements of project.

2.02 PRODUCTS AND SYSTEMS

A. Basis-of-Design Manufacturer: Pro-Bel Group of Companies or comparable products by one of the following;

1. Guardian Fall Protection.
2. Peak Fall Protection, Inc.
3. Summit Anchor Company.
4. Thaler Metal Industries, Inc.

2.03 DESIGN PERFORMANCE REQUIREMENTS

A. Design fall protection system to suit project requirements to AISC S342L and as indicated.

B. Locate anchorages to suit suspension equipment specified.

C. Design anchor components for cleaning and suspended maintenance equipment to ASME A120.1.

1. Ensure compatibility with industry standard equipment.
2. Anchorage and anchor components: Designed by Engineer qualified in design of window cleaning and suspended maintenance equipment and licensed in State of Ohio.

D. Design system fall arrest safety anchors and equipment supports to AISC S342L (including supplement No.1) and ANSI/IWCA I-14.1, and as follows:

1. Comply with OSHA 1910, Subpart F, Appendix C.
2. Fall Arrest Safety Anchors:

a. Fall arresting force safety factor of 2 to 1 without permanent deformation: 1800 lbs (8.0 kN) minimum.
b. Fall arrest force against fracture or detachment: 5,400 lbs minimum.

2.04 EQUIPMENT

A. Anchors.

B. Double Lanyard Horizontal Lifeline Systems.

2.05 ANCHORS (RF P-1, RF P-2)

A. Basis-of-Design Product: Pro-Bel Group of Companies; Model No. PBE75 Roof Anchors.

B. Safety U-bars: Stainless steel to ASTM A276,Type 304 with 35 Ksi (240 MPa) minimum yield strength.

1. U-bar: 0.75 inches (19 mm) minimum diameter material with 1.5 inches (38 mm) eye opening.

C. Hollow Steel Section (HSS) Piers: Mild steel, Type 300W with 50 Ksi (350 MPa) minimum yield strength, hot dipped galvanized to ASTM A123/A123M

1. Wall thickness to suit application.

D. Plate and other sections: Mild steel, Type 300W with 44 Ksi (300 MPa) minimum yield strength, hot dipped galvanized to ASTM A123/A123M

1. Wall thickness to suit application

E. Seamless Spun Aluminum Flashing (for Roof Anchors): To AA ADM-1 Type 6061-T6 alloy and to ASTM B221.

1. Deck flange flashing: conformable mastic tape and torch applied heat-shrink rubber collar flashing or detachable watertight stainless steel cap.
2. Acceptable material: Pro-Bel Group, Aluminum Deck Flange Flashing.

F. Miscellaneous Bolts, Nuts and Washers: Stainless steel to ASTM A276, Type 304 with 5 Ksi (240 MPa) minimum yield strength.

2.06 DOUBLE LANYARD HORIZONTAL LIFELINE SYSTEM (RF P-3)

A. Basis-of-Design Product: Pro-Bel Group of Companies; Horizontal Lifeline Fall Arrest System Assembly-Non-Hands Free (Double Lanyard) System-Pro-Shock.

B. Stainless steel to ASTM A492, Type 316, 0.3125 inches (8 mm) minimum diameter cable, 9127 lbs (40 kN) minimum breaking strength with permanently swedged cable ends.

C. Data plate: Ensure non-corrosive data plate stating Maximum Service Capacity of cable, Manufacturer's Name, Serial No., Manufacturing Date, rated load and other pertinent information is prominently displayed at cable system entry points.

D. Tensioner: Stainless steel turnbuckle to ASTM A167, Type 316.

E. Harness: Manufacturer's standard full body harness with double shock absorber lanyard. Provide at least 3 harnesses. Provide self-retracting lifelines.

2.07 SOURCE QUALITY CONTROL

A. Ensure Fall Protection equipment components and materials are from single manufacturer.

PART 3 - EXECUTION

3.01 INSTALLERS

A. Provide experienced and qualified technicians to carry out erection, assembly and installation of fall protection and suspended maintenance equipment system.

B. Do steel welding to AWS D1.2/D1.2M.

C. Do aluminum welding to AWS D1.1/D1.1M.

3.02 MANUFACTURERS INSTRUCTIONS

A. Compliance: Comply with manufacturer’s written data, including product technical bulletins, product catalog installation instructions and Pro-Bel Group technical data sheets.

3.03 EXAMINATION

A. Site Verification of Conditions:

1. Verify that substrate conditions which have been previously installed under other sections or contracts, are acceptable for product installation in accordance with manufacturer's instructions prior to installation of window washing equipment.
2. Inform Architect of unacceptable conditions immediately upon discovery.
3. Proceed with installation only after unacceptable conditions have been remedied.

3.04 PREPARATION

A. Ensure structure or substrate is adequate to support complete window washing equipment system.

B. Ensure structural steel to receive safety anchors has adequate bearing surface as indicated on shop drawings and has 100% welds between anchors and structural steel.

3.05 INSTALLATION

A. Coordinate fall protection work with work of other trades, for proper time and sequence to avoid construction delays.

B. Install fall protection equipment plumb and level in accordance with manufacturer's written instructions.

C. Mechanically fasten anchors in accordance with manufacturer's recommendations

D. Accurately fit and align, securely fasten and install free from distortion or defects.

E. Deform threads of tail end of anchor studs after nuts have been tightened to prevent accidental removal and vandalism.

F. Mark anchorage points with bright/fluorescent paint and identify them with weatherproof tags/labels.

3.06 FIELD QUALITY CONTROL

A. When necessary have the manufacture assist in installation.

B. Manufacturer's Field Services: Have manufacturer's technical representative schedule site visits to review work as follows:

1. After delivery and storage of products.
2. When preparatory work for which work of this Section depends is complete, but before installation begins.
3. 2 times during progress of work at 25% and 60% of completion.
4. Upon completion of work, after cleaning is carried out.

C. Testing: Test on site 100% of anchors relying upon chemical adhesive fasteners using load cell test apparatus in accordance with manufacturer's written recommendations.

3.07 ADJUSTMENT

A. Lubricate moving parts to operate smoothly and fit accurately.

B. Complete "Initial Inspection - Certification for Use" form included in Equipment Manual and Inspection Log Book provided by manufacturer.

3.08 FINAL CLEANING

A. Upon completion, remove surplus and excess materials, rubbish, tools and equipment.

3.09 PROTECTION

A. Make good damage to adjacent materials caused by fall protection equipment installation.

3.10 MAINTENANCE

A. Regularly and systematically examine, clean, adjust and lubricate moving parts.

B. Repair or replace parts of fall protection equipment whenever required due to defect and normal wear and tear.

C. Use only standard parts of product line of manufacturer of window washing equipment.

D. Maintain locally adequate stock of parts for replacement or emergency purposes.

E. Perform work during regular trade working hours satisfactory to Owner.

F. Provide emergency call-back at no extra cost and ensure fulfillment of maintenance and emergency service without undue loss of time to Owner.

G. Ensure that maintenance personnel register with designated building personnel at time of inspections and maintenance.

END OF SECTION 112424

21 05 01 BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, and Supplementary Conditions, including Divisions 00 and 01, apply to work specified in this Division.

B. The project drawings and specifications define scope of work for the various divisions. Such assignments of work are not intended to restrict the Construction Manager in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in Division 21. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Each bidder shall inspect the project site. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect and/or Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect and/or Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect and/or Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install piping and equipment.

D. The Architect and/or Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of

concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's / Construction Manager's decision shall be final in regard to the arrangement of equipment, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings and necessary drains required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect and/or Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect and/or Construction Manager.

1.5 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.6 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work, and within 90 days of system acceptance, these drawings shall be turned over to the Architect and/or Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.7 Operating and Maintenance Manuals

A. Assemble three copies of operating and maintenance manuals for the Fire Suppression work.

B. All "approved" shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Pipe pressure test reports shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted

to the Engineer and Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

1.8 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect the work and develop their own punch list to confirm that it is complete and finished. Then notify the Architect or Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.9 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner. Use of equipment for temporary system use is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and/or labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as re-tightening or repacking glands, greasing, oiling and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 - General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

A. All equipment and appliances shall be listed and labeled in accordance with the Building and Fire Codes. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance.

2.3 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe or equipment layout, or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included.

2.5 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, pump curves, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following Fire Suppression equipment and materials shall be submitted:

1. Pipe, fittings and joining methods.
2. Firestopping systems for pipe penetrations.
3. Pipe hangers.
4. Valves.
5. Gauges.
6. Sprinklers and accessories.
7. Wet pipe system components.
8. Fire department connections.

PART 3 - EXECUTION

3.1 Pipe Testing

A. Pipe testing for fire suppression piping shall be as described below and in Section 21 11 13 Facility Water Distribution Piping and Section 21 13 13 Fire Suppression Sprinkler System.

B. Ensure that air is vented from piping when piping is hydrostatically tested.

C. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

D. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

3.2 Pipe Cleaning

A. Before placing each piping system in operation, the piping system shall be thoroughly flushed out with clean water.

B. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect and/or Engineer that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

END OF SECTION

21 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's / and / Engineer's / and / any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the

Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

ELECTRONIC FILES
HEAPY RELEASE FORM TO CONTRACTORS

Project: GDRTA Bus Garage and Wash

Dayton, Oh

Owner: GDRTA

Heapy Engineering Project Number: 2023-07202

Heapy Engineering Project Manager: Don Timmer

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider’s Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

    b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

    d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by

the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Recipient Address: _____

    Name of authorized Recipient Representative: _____

    Title of authorized Recipient Representative: _____

    E-mail address of authorized Recipient Representative: _____

    Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ CD-ROM ☐ DVD-ROM ☐ Heapy FTP ☐ User's FTP site ☐ Flash Drive

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 20XX DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG

Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 21 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.
Available electronic Revit file format:
☐ 20XX .RVT

Cost of Preparation of Division 21 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

21 05 04 BASIC FIRE SUPPRESSION MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Construction Water

A. Refer to Division 01 - General Requirements, for information regarding construction water.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Fire Suppression work shall be performed by Contractors that are fully certified by the State or Authority Having Jurisdiction.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager. All piping shall be elevated from grade for on-site storage, and all open ends shall be covered. Plastic piping shall be protected from direct and indirect sunlight.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas. Work shall be conducted in strict adherence to the facility Construction and Renovation Infection Control Standards.

3.3 Cutting and Patching New Buildings

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange for the provision of openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work. Any damage caused to the building in this work shall be repaired or rectified.

C. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

3.4 Painting

A. In addition to any painting specified for various individual items of equipment, provide the following painting:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas,

mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.

2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials, except sprinklers, which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up. Sprinklers and sprinkler assemblies shall be replaced with new.
4. Apply Z.R.C. Galvilite / 221 cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

B. Paint, surface preparation and application shall conform to the paint manufacturer's instructions / applicable portions of the Painting section of Division 09 Specifications. All rust must be removed before application of paint.

C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

END OF SECTION

21 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and pipe layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the OBC / Chapter 1, and Chapter 7, and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of UL firestopping assemblies and installation instructions. Submittals shall include all information required in the OBC Chapter 1, and Chapter 7.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 21 05 07 Piping Materials and Methods for Fire Suppression for pipe sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION

21 05 07 PIPING MATERIALS AND METHOD FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 Piping materials and methods for piping common to Division 21 – Fire Suppression shall be as specified herein and as shown on the drawings.

1.2 Included in this section are:

A. Pipe, fittings and joining methods.

B. Unions and flanges.

C. Pipe sleeves, openings, curbing and escutcheons.

D. Installation methods of piping.

1.3 Refer to other Sections in Division 21 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.4 Refer to Section 21 05 05 Firestopping and for firestopping requirements.

1.5 Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

1.6 Welding procedures, testing and welder performance shall comply with The American Welding Society Welding Handbook, AWS B2.1, Specification for Welding Procedure and Performance Qualification and National Welding Institute.

1.7 Pipe threads shall be cut to ASME B1.20.1, Pipe Threads, General Purpose.

1.8 Brazing procedures shall be per ANSI B31.5 and the ASTM Boiler and Pressure vessel Code SFA-5.8 Section II.

1.9 Soldering procedures per ANSI B16.18.

1.10 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe.

1.11 Pipe sleeves shall be provided where below grade pipes penetrate foundation walls. Relieving arches shall be provided for all below grade pipes passing below structural footings.

1.12 Sleeves are not required:

A. In floor slabs on grade.

B. In stud and gypsum board or plaster walls and partitions which are not fire rated.

C. For above grade uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.

D. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.

E. In large floor openings for multiple pipe risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after pipes are set.

1.13 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 For detail of pipe and fitting products see Section 21 13 12 Fire Suppression Piping.

2.2 Unions and flanges shall be:

A. Unions on copper tubing, all bronze construction 150 lb., solder ends.

B. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

C. Flanges on steel pipe with welded or screwed joints, 2.5 inches and larger. Gaskets shall be 0.0625 inches thickness, ASME B16.21, full face compressed sheet suitable for temperature and pressure ranges of the application.

D. Mechanical joints associated with grooved end pipe are acceptable in lieu of unions and flanges.

2.3 A dielectric connector shall be incorporated at each connection between ferrous and non-ferrous piping. Connectors shall be:

A. Dielectric coupling with non-conductive polymer liner, Victaulic Style 47, Gruvlok "Di-Lok" and Lochinvar Corp. "V-Line" Dielectric fitting on service pressures less than 300 psi.

2.4 Pipe sleeves shall be:

A. Schedule 40 black steel pipe, ASTM A53, Type E, Grade A or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.

B. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

C. Cast iron, Schedule 40 galvanized steel or Schedule 40 PVC pipe in below grade foundation walls. The pipe sleeve shall be a minimum two pipe sizes larger than the penetrating pipe. Refer to paragraph E below for pipe sleeve requirements in exterior below grade walls.

D. Galvanized sheet metal for existing pipes passing thru new poured concrete floors (18 gauge) and thru new walls and partitions (26 gauge).

2.5 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Piping shall be installed consistent with good piping practice, run concealed wherever possible and located as to be protected from damage by freezing. Coordinate with other trades to attain a workmanlike installation.

3.3 Piping shall be supported as specified in Section 21 05 29 Hangers and Supports for Fire Suppression Piping. Piping with mechanical joints for grooved end steel pipe shall be supported in accordance with the manufacturer's recommendations. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before the system is accepted.

3.4 Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage.

3.5 Close open ends of piping during installation to keep interior of the pipe clean.

3.6 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the N.E.C..

3.7 Unions and flanges shall be installed at pipe connections to equipment and as required for erection purposes.

3.8 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect and/or Engineer.

3.9 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor.

3.10 Refer to 21 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.11 In lieu of firestopping and where permitted by the OBC, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar) in compliance with ASTM E119 test requirements.

3.12 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe shall be closed with sealant or caulking to retard the passage of noise or smoke. Sealant or caulking shall be applied per the manufacturer’s requirements, including opening width limitations, backing materials, sealant or caulking thickness, etc. Sealants and caulking shall be compatible with the materials they are in contact with, and sealants and caulking in direct contact with copper piping shall be silicon-based to minimize the potential for corrosion.

END OF SECTION

21 05 09 EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 Excavate for all underground exterior piping. Backfill to finish grade or to levels consistent with site work activity. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition or as is consistent with site activity. All work shall comply with requirements set forth in Division 31 – Earthwork and Division 32 – Exterior Improvements.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.

1.3 Contact the Ohio Utilities Protection Service (1-800-362-2764) sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 A utility locator service shall be engaged to locate, mark and identify private lines and other utilities that are not located by the means mentioned above.

1.5 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31 - Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Trenches for interior and exterior piping shall be over excavated and the pipe shall be laid on 6 inches minimum depth sand bed.

3.2 Backfilling and compaction of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with approved backfill materials to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials up to 18 inches above the top of the piping. The remainder shall be with similar materials or with excavated material having no large clods, stones or rocks.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of. Refer to Division 31 - Earthwork for compaction requirements.

3.4 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions.

3.5 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included so that no additional cost will accrue to the Owner.

3.6 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.7 All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the pipe.

END OF SECTION

21 05 19 GAUGES FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 Pressure gauges shall be provided as shown on the drawings and as specified herein.

1.2 Gauges furnished as a part of factory assembled equipment are specified with such equipment.

PART 2 - PRODUCTS

2.1 Manufacturers products listed below are basis of design. Other acceptable manufacturers are Winters, Milijoco or Palmer Instruments.

2.2 Pressure Gauges

A. Pressure gauges shall be Bourdon tube type with 4.50 inch dial and cast aluminum case, equal to Trerice 600CB Series. Accuracy shall be 1 percent at mid-range.

B. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.

C. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

PART 3 - EXECUTION

3.1 Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:

A. Fire Suppression - The incoming water service.

3.2 Gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.

END OF SECTION

21 05 29 HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 All interior and exterior piping shall be supported from the building structure.

1.2 All products and assemblies installed within a plenum shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other approved equal manufacturers are B-line, Erico, Mason, PHD and TOLCO.

2.2 Hangers and supports for horizontal piping shall be UL listed and equal to:

A. General service – clevis type Anvil Fig. 260.

B. Copper tubing – adjustable pipe ring - Anvil Fig. 97C (plastic coated).

C. Pear shaped band hangers with adjustable swivel ring, lock nut and rod attachment - Anvil Fig. 69.

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis, trapeze and swivel ring type hanger.

Pipe Sizes	Min. Rod Dia.
4” and smaller	0.375"
5” to 8"	0.50"
10” to 12”	0.625”

2.4 Hanger rod attachment devices for attachment to the structure shall be:

A. Pre-set concrete inserts.

B. After-set steel expansion type concrete inserts.

C. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

D. Channel support systems equal to Unistrut or Hilti.

E. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.5 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as specified herein and, in addition, spacing and hanging methods in conformance with NFPA Standards when more stringent.

A. Steel pipe (vertical) – at the base, at each floor level, and 15 ft. maximum spacing.

B. Steel pipe (horizontal) – 12 ft. intervals for piping 1.25 inch size and smaller, 15 ft. spacing for piping 1.5 inches and larger pipe.

C. Copper tubing (vertical) – at the base, at each floor level, and 10 ft. maximum spacing.

D. Copper tubing (horizontal) – 8 ft. spacing for tubing 1 inch size and smaller, 10 ft. spacing for 1.25 inch and 1.5 inch sizes, 12 ft. spacing for tubing 2 inch thru 3 inch size and 15 ft. spacing for 4 inch and larger size.

3.2 In piping systems with rolled or cut groove end pipe and mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported between any two couplings nor left unsupported whenever a change in direction takes place. Vertical piping shall be supported at normal specified intervals or every other pipe length, whichever is more frequent. The base of the riser or base fitting shall be supported.

3.3 Attachment of pipe hangers to the structure shall be with:

A. Pre-set concrete inserts in concrete construction of 4 inch minimum depth.

B. After-set concrete inserts, in 4 inch minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

C. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment. Attachment to the bar type joists shall be at joist panel points only.

D. In fabricated steel joist construction (bare joists) attachment of hanger rods shall be through the gap of the joist cord angles so that loads are concentrically applied to the steel joist in accordance with the rules of the Steel Joist Institute and the Architect / Structural Engineer. Connections made to the outer edge of one cord angle.

E. Unistrut type channel support system may be utilized where a number of pipes are run parallel or to span below other utilities and equipment. Channel shall be pre-set or attached to the structure with inserts or clamps.

F. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

G. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.4 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.5 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.6 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer

END OF SECTION

21 05 53 IDENTIFICATION OF FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 Identification of fire suppression equipment shall consist of equipment labeling, pipe marking and valve tagging as specified hereinafter.

1.2 Pipe markings shall be applied to all piping.

1.3 Underground exterior piping shall be identified with a continuous plastic line marker tape as described in the service piping sections and this section.

1.4 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inch x 11 inch paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - South wing Zone 1).

1.5 Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

1.6 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.7 The door (interior and/or exterior) to the sprinkler system riser / fire pump room shall be labeled as directed by the local fire department.

1.8 Coordinate pipe markings and valve tags to ensure similar markings.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

B. Stencil painted identification, 2 inch high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Pipe markings shall be:

A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe or pressure-sensitive vinyl markers similar to the above.

B. On piping 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.3 Underground line marker tape shall be permanent bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.4 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "F" (for fire suppression) and the designated number.

2.5 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in Division 21 identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Division 21, 22 and 23 labeling, marking and tagging shall be coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings.

3.5 Pipe markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces.

C. At 50 ft. centers in other exposed locations.

D. On mains at each branch take-off.

E. At least once in each room.

3.6 Refer to appropriate sections of this specification for installation of underground line marker tape.

3.7 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be framed under glass or plastic / laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION

21 11 13 FACILITY WATER DISTRIBUTION PIPING FIRE OR FIRE AND DOMESTIC

PART 1 - GENERAL

1.1 Exterior water service(s) shall be provided from 5' feet outside the building to a flanged connection inside the building for the fire suppression system and the domestic water system.

1.2 Pipe, fittings, hydrants, valves and related devices and materials shall meet UL and AWWA standards, Water Department and Fire Department standards and requirements of.

1.3 Installation shall conform to NFPA 24 and AWWA standards and requirements of the local Fire Department and other applicable fire codes.

1.4 The installing contractor shall be certified by the State Fire Marshal's office for such work.

PART 2 - PRODUCTS

2.1 Water service pipe shall be ductile iron conforming to ANSI/AWWA C151/A21.51, Class 53 or 51. Fittings shall be 250 lb. pattern ductile iron, ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Pipe and fittings shall be cement lined, ANSI/AWWA C104/A21.4. Pipe and fitting connections shall be mechanical joint or "push-on" compression type joint with rubber ring gasket, ANSI/AWWA C111/A21.11. Each joint shall be restrained with wedge-action, self-actuating mechanical joint restraint equal to "Megalug".

PART 3 - EXECUTION

3.1 Excavation, bedding, laying of pipe, backfill and surface restoration shall conform to Section 21 05 09 Excavation, Backfill and Surface Restoration, AWWA C600 for ductile iron, ASTM D2774 for plastic pipe and manufacturer's instructions.

3.2 Pipe shall be laid at a depth affording 4.50 ft. cover from finished grade to the top of the pipe.

3.3 Elbows, tees and offsets shall be held in place with heavily tarred steel clamps and concrete thrust blocks sized and placed in accordance with AWWA. Provide field lock gaskets when required by the Water Department.

3.4 Service entrance pipe shall be placed below the footer of the building wall and elbowed up thru the floor slab, terminating with a blind flange (for test purpose). Align flange bolt holes to ensure the axis of the valve will be perpendicular to the wall.

3.5 All service piping shall be hydrostatically tested for 2 hours at 200 psi or, when the maximum static pressure exceeds 150 psi, test pressure shall be 50 psi above static pressure. Test shall be witnessed by the authority having jurisdiction.

END OF SECTION

21 13 12 FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 Piping, valves and devices for the fire suppression system shall be provided as shown on the drawings, as specified and as required for a complete system.

1.2 Piping and associated devices and materials shall conform to provisions of Section 21 05 07 Piping Materials and Methods for Fire Suppression, Section 21 05 29 Hangers and Supports for Fire Suppression Piping and as specified in this and other Fire Suppression sections.

1.3 Pipe, fittings and joints shall conform to specifications and standards references of NFPA 13 Standard for the Installation of Sprinkler Systems.

1.4 Fire suppression system materials and components shall be UL listed for fire suppression service. Piping, fittings, valves and system components shall be rated at not less than 175 psi or greater so that system pressures do not exceed working pressure ratings.

1.5 Welding in place will be permitted only if written approval is obtained from the authority having jurisdiction. Welders and welding procedures in both the shop and in the field shall conform to AWS B2.1, Specification for Qualification of Welding Procedures and Welders for Piping and Tubing. Welding of galvanized piping is prohibited.

PART 2 - PRODUCTS

2.1 Pipe, fittings and joining methods shall be:

A. TYPE F1 - Wet Pipe System
Pipe - Schedule 40 black steel, ASTM A53, Type E or F, or ASTM A135. Fittings and joints - malleable or cast iron screwed type or flanged.

B. TYPE F2 - Wet Pipe System
Pipe - Schedule 40 black steel, ASTM A53, Type E or F, or ASTM A135, with mechanically rolled or cut groove ends.
Fittings and joints – grooved-end joint with malleable or ductile iron body, ASTM A-536 or A-47 and nitrile or EPDM gaskets. Victaulic "Firelock" Style 005 or 009 rigid, Victaulic IGS or equal by AnvilStar “Gruvlok” or Tyco/Grinnell. All fittings and couplings shall be of the same manufacturer.

C. TYPE F6 - Wet Pipe System
Pipe - Schedule 10 black steel, ASTM A135 with mechanically rolled groove ends, in sizes 2 inches and larger. Fittings and joints – grooved-end joint with malleable or ductile iron body, ASTM A-536 or A-47 and nitrile or EPDM gaskets. Victaulic “Firelock” Style 005 or 009 rigid or equal by AnvilStar “Gruvlok” or Tyco/Grinnell. All fittings and couplings shall be of the same manufacturer.

2.2 Grooved-end coupling specialty fittings and accessories such as ANSI class flange adaptors, reducing couplings and combination outlet-couplings that utilize grooved-end joining with torsion nuts and bolts shall be permitted. Other couplings and accessories, such as boltless couplings, and hole-cut mechanical – t outlets, strapless outlets and similar fittings using pipe-surface seals shall not be permitted unless specifically approved by the Engineer.

2.3 Valves on the interior piping of the fire suppression systems shall be UL listed for fire suppression application. Valves shall be manufactured by Nibco, whose catalog numbers are listed below, or equal by Kennedy, Hammond or Watts.

A. Butterfly Valves.

Type A4. 2 inches and larger.
Nibco LD3510-8, 250 psi w.w.p.(dead-end service), ductile or cast iron tapped lug body, nickel plated ductile iron disc, molded in EPDM seat, 416 S.S. stem, worm-gear operator with handwheel and indicator. Valves with integral supervisory switches are acceptable if supervisory mechanism is UL listed.

B. Ball Valves.

Type B7. 2 inches and smaller.
Nibco KT-505-W-8, 300 psi w.w.p. two-piece bronze body, screwed ends, chrome plated brass ball, bronze stem, full port, TFE seat and seal. Gear box operator with handwheel and indicator. Valves with integral supervisory switches are acceptable if supervisory mechanism is UL listed.

Type B8. 1" and smaller, for trim and drain use only.
Nibco KT-580-70-UL, 300 psi w.w.p., two-piece bronze body, screwed ends, chrome plated brass ball, bronze stem, full port, TFE seat and seal, handle.

Type B9. 1.25" to 2", for trim and drain use only.
Nibco KT-580-70-UL, 300 psi w.w.p., two piece bronze body, screwed ends, chrome plated brass base, bronze stem, standard port, TFE seat and seal, handle.

C. Check Valves.

Type C10. 2 inches and smaller.
Nibco KT-403-W, 200 psi w.w.p., swing check, bronze body, threaded bonnet, Buna-N faced disc.

Type C11. 2.50 inches and larger.
Nibco F-908-W, 175 psi w.w.p., swing check, cast iron body and bonnet, bronze mounted, renewable seat and disc, flanged ends, rubber faced disc, drilled and tapped ball drip boss with plug.

Type C12. 2.50 inches and larger.
Nibco KW-900-W, 250 psi w.w.p., ductile iron body, wafer style, bronze disc, molded Buna-N resilient seat, stainless steel spring and pins.

2.4 Valves of equal construction and features as those listed above, and with ends compatible with grooved-end pipe mechanical joint couplings are acceptable on such systems, and shall be manufactured by the coupling system manufacturer used on this project.

2.5 Double Check Detector Assembly

A. Double check detector assembly shall be designed for low-hazard cross-connections and shall consist of:

1. Two independent spring loaded check valves.
2. Shutoff valves, one upstream and one downstream. Resilient seated O.S.&Y. gate type.
3. Ball type test cocks.
4. By-pass detector water meter, check valve, isolation valves and by-pass piping, 0.75 inches size. (Verify meter requirements with water purveyor.)

B. Units shall have coated cast iron or stainless steel bodies and flanged ends.

C. All components of the assembly shall be constructed of corrosion resistant materials or waterways shall be coated with FDA approved epoxy or other corrosion protection. The assembly shall conform to ASSE Standard 1015 / 1048 and AWWA Standard C-510.

D. Double check detector assembly shall be Watts Series 709/774 DCDA or equal by Apollo, Wilkins, Conbraco, AMES or FEBCO. Assemblies shall be UL and FM approved with UL and FM approved shutoff valves upstream and downstream.

2.6 Valves where designated as supervised type shall be suitable for mounting of an electrical supervisory switch to monitor the valve position, open or closed.

2.7 Unions, flanges, pipe sleeves and firestopping shall be as described in Section 21 05 07 Piping Materials and Methods for Fire Suppression and Section 21 05 05 Firestopping.

2.8 Pipe hangers and supports shall be UL listed or FM approved and shall be as described in Section 21 05 29 Hangers and Supports for Fire Suppression Piping.

2.9 Supervisory attachments shall be UL listed and approved for fire alarm signaling use. Devices shall contain one Form “C” signal contact having 120 VAC, 7.5 amps minimum rating and shall be compatible with the type valve on which it is to be installed.

PART 3 - EXECUTION

3.1 Installation of piping, valves, hangers, sleeves and other components shall conform to NFPA 13 for sprinkler systems, Section 21 05 07 Piping Materials and Methods for Fire Suppression, and Section 21 05 29 Hangers and Supports for Fire Suppression Piping.

3.2 Supervisory switches for valves shall be furnished and installed. Make all final adjustments.

3.3 Grooved-end joint type couplings shall be installed in strict conformance with manufacturer’s recommendations, including torquing of coupling bolts to recommended levels.

3.4 Backflow preventer(s) shall be located and installed in accordance with the manufacturer’s recommendations and Water Department’s requirements. Clearances and elevations shall afford easy access for testing and servicing. Devices shall be tested at the time of being put into service. Submit test data in O & M manuals.

END OF SECTION

21 13 13 FIRE SUPPRESSION SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 Provide a complete wet-pipe sprinkler systems as outlined on the drawings and as specified.

1.2 The sprinkler system shall conform to requirements of NFPA 13, OBC and other requirements of the authority having jurisdiction.

1.3 All materials and devices, as appropriate, shall be UL Listed, and acceptable to the authority having jurisdiction.

1.4 Bidders on Division 21 work shall be regularly engaged in the installation of the respective fire control systems and shall be fully certified by the State or authority having jurisdiction, as applicable. Bidders shall provide a list of approved operational installations upon request.

1.5 Obtain and pay for a permit and other applicable fees.

1.6 Perform a hydrant flow test to verify data on the drawings and to serve as the basis for hydraulic calculations in sizing of piping and other elements of the system. Calculations shall include not less than a 5 psi safety factor. Service and main pipe sizes shown on the drawings shall not be reduced. Flow tests performed within 6 months of the date of permit will be acceptable. A copy of the flow test report shall be included with the submitted hydraulic calculations.

1.7 Hydraulic calculations shall be based on minimum area of operation as indicated on the drawings. Area of operation reduction(s) for quick response, extended coverage sprinklers are acceptable.

1.8 Installation drawings for the sprinkler system shall be developed showing all information needed to obtain approval from the authority having jurisdiction. A summary sheet shall be included showing all pertinent information per NFPA 13. Drawings shall be submitted to the Engineer for review and to the authority having jurisdiction and to the Owner's insurer for approval.

1.9 On gridded systems (if provided) velocities shall be a maximum of 20 fps for pipe sizes 2 inches and smaller and 30 fps for 2.50 inches and larger. No gridded system branch lines (serving multiple sprinklers) shall be smaller than 1.25 inches. Velocities on all other systems shall be a maximum of 30 fps for all pipe sizes.

1.10 Pipe, fittings, valves, accessories, devices and installation shall be as specified in 21 13 12 Fire Suppression Piping. Refer to 21 13 15 for Fire Suppression Equipment.

PART 2 - PRODUCTS

2.1 Sprinklers, valves, and all other associated items shall be manufactured by Globe, Reliable, Tyco, Viking or Victaulic.

2.2 Sprinklers, unless otherwise noted, shall be quick-response frangible bulb or fusible solder style having a temperature range suitable for the application and pressure rating in excess of the maximum system pressure, with a minimum operating pressure of 175 psi. Refer to the drawings for sprinkler types, finishes and features. Escutcheon plates for pendent and sidewall sprinklers shall be two-piece to allow removal of the escutcheon and sprinkler without disturbing the ceiling or wall. Escutcheon plates shall be a part of the listed sprinkler assembly.

2.3 Extended coverage sprinklers are acceptable if supported by on site street pressure and hydraulic calculations.

2.4 Special coatings shall be factory applied by the sprinkler manufacturer only. Field application of coatings or finishes that would nullify the UL listing or FM Global approval of the sprinkler is prohibited.

2.5 Spare sprinklers and sprinkler wrenches shall be furnished in accordance with the requirements of NFPA 25. Stock of spare sprinklers shall be representative of, and in proportion to, the number of each type, temperature, and pressure rating of the sprinklers installed. At least one wrench of each type shall be provided. Provide a wall mounted steel cabinet for spare sprinklers and wrenches.

2.6 All components shall be compatible with the respective system, including but not limited to trim pieces, valves, solenoids, monitoring/control modules, waterflow switches and pressure switches.

2.7 All supervisory and alarm switches shall be UL Listed and/or FM Approved for fire alarm signaling use. Devices shall contain at minimum one single pole double throw (SPDT) “Form C" signal contacts having 120 VAC, 7.5 amps minimum rating unless otherwise specified. Devices shall be NEMA 4 rated unless otherwise specified.

2.8 The system control valve shall be a listed indicating type valve. A control valve shall be provided for each individual sprinkler zone in project. The control valve shall be UL Listed and FM Approved for fire protection installations. The system control valve shall be rated for normal system pressure, but in no cases less than 175 psi.

A. A supervisory (tamper) switch shall be provided to monitor the open position of the control valve. Supervisory switch shall be compatible with and monitored by the local fire alarm control panel. Switch shall be suitable for mounting to the type of control valve to be supervised open. Switch shall be tamper resistant and contain one set of SPDT Form C contacts arranged to transfer upon closure of the valve of more than two rotations of the valve stem.

2.9 Wet-pipe system valve assemblies shall be complete with necessary components, accessories and piping, and shall include the following:

B. Water Flow Alarm

1. Water flow alarm switches shall be UL Listed for fire alarm signaling use. Switch shall be vane type with a pipe saddle and NEMA 4 rated tamper-resistant enclosure. Device shall contain two SPDT Form “C” signal contacts. The device shall sense water movements and be capable of detecting a sustained flow at 10 GPM. Water flow alarm switches shall include an adjustable retard mechanism having a range of not less than 0 to 60 seconds. Size flow devices according to related pipe size. Provide enlarged section of pipe where necessary.

C. Alarm test modules equal to AGF Manufacturing “TESTANDRAIN®”, Victaulic Style 720 or Grinnell Model F350 may be used at the Contractor’s option.

PART 3 - EXECUTION

3.1 Pendent type sprinklers shall be located in the center of square suspended ceiling tile and at the center or at quarter points of the long axis of rectangular suspended ceiling tile. The acceptability of alternate layouts will be contingent upon obtaining the Architect's approval regarding the location of the sprinklers. Additional sprinklers, if not more than 5 percent of the total number required, and related piping that may be required to maintain the continuity of a desired ceiling pattern or to accommodate an unforeseen condition shall be deemed to be included in the contract.

3.2 Piping Installation

A. The location of piping and devices shall be coordinated with other trades to ensure proper fit of all building systems and adequate access to test stations, control valves and water flow alarms. Sprinkler piping shall be so located as to be protected from damage by freezing.

B. Piping in exposed areas shall be installed without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

C. In areas with suspended or drop ceilings and in areas with concealed spaces above the ceiling, piping shall be concealed above ceilings. Piping shall be inspected, tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas shall be concealed.

3.3 Sprinkler Installation

A. Drop nipples to pendent sprinklers shall consist of minimum 1 inch pipe with a reducing coupling into which the sprinkler shall be threaded. Arm-overs shall be used to connect sprinkler to branch piping where possible.

B. Sprigs to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

3.4 Unless indicated otherwise on the drawings, the inspector's test connection shall consist of a 1 inch pipe connected at the riser as a combination test and drain valve with a test valve located 7 feet above the finished floor to a smooth bore brass outlet equivalent to the smallest orifice sprinkler. A painted sign (ref. requirements of 3.11) shall be located below the ceiling and attached to the valve with the words "Inspector's Test". The discharge point shall be located as to not cause damage to surrounding construction or landscaping during testing discharge.

3.5 Flow alarm switches for wet systems and supervisory attachments for valves shall be furnished and installed. Make all final adjustments.

3.6 The entire piping system, including the water supply piping specified in Section 21 11 13 and piping extended to the fire department connection shall be hydrostatically tested at 200 psig minimum and not less than 50 psi above the maximum system pressure. Test pressure shall be applied for a period of not less than 2 hours and shall be measured at the low point of the piping being tested. Piping shall show no leakage by visual inspection and by pressure gauge reading. On dry pipe and preaction system successfully complete 24 hour air pressure test prior to conducting hydrostatic test. Testing procedure and pertinent data shall be recorded and made available to the Owner and to the authority having jurisdiction. Remove air from system piping before proceeding with the test.

3.7 Provide system drain valves, flow test valves, related accessories and discharge and drain piping. Piping shall be extended to a discharge location outside the building.

3.8 Provide a valve identification sign near each zone valve of each system riser. Signs shall also be provided for each inspector test valve, main drain/test valve, auxiliary drain, and similar valves as required by NFPA 13. Sign shall indicate location of design area or areas, discharge density over the design area or areas, required flow and residual pressure demand at base of riser, occupancy, and hose stream demand included in addition to the sprinkler demand. Sign shall be a minimum of 6 inches wide by 2 inches high with red letters on a white background or white letters on a red background. Sign shall be non-corrosive metal or plastic and shall be permanently attached to the riser.

3.9 Conduct all flow and flow alarm tests as required by NFPA 13.

END OF SECTION

21 13 15 FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 Fire control equipment shall be provided as specified and as shown on the drawings. All items provided shall be UL listed for fire suppression use and must be acceptable to the authority having jurisdiction and the Owner's insurer.

PART 2 - PRODUCTS

2.1 Equipment shall be as manufactured by Potter Roemer, Croker, Guardian, J.L. Industries or Elkhart/Larsens. Outlet threads shall conform to the standards of the servicing fire department.

2.2 Wall-Mounted Fire Department Connection:

A. Wall-mounted fire department connection shall be a cast aluminum Storz connection equal to Potter-Roemer 5795 Series with a single 4 inch/ 5 inch / 6 inch inlet and 4 inch / 6 inch outlet, coupling, internal strainer screen, 30 degree elbow pointing downward, chain secured cap and escutcheon plate. Escutcheon 0.333 turn plate shall be brass with rough chrome plate / polished chrome plate finish.

B. The fire department connection shall be identified with “Auto Sprinklers” lettering cast or cut in the escutcheon plate.

PART 3 - EXECUTION

3.1 Fire department connections shall have “Auto. Sprinkler” label cast in the escutcheon plate. Install a line size check valve and automatic ball drip in conjunction with each fire department connection provided.

3.2 Fire department connection arrangement and mounting height (18 inches minimum /48 inches maximum above grade) shall conform to servicing fire department standards.

END OF SECTION

22 05 01 BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, Supplementary Conditions including Divisions 00 and 01, apply to work specified in this Division.

B. The project drawings and specifications define scope of work for the various divisions. Such assignments of work are not intended to restrict the Construction Manager in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in Division 22. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Each bidder shall inspect the project site and the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect and/or Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect and/or Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect and/or Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install piping and equipment.

D. The Architect and/or Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall

be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's / Construction Manager's decision shall be final in regard to the arrangement of equipment, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary drains and minor valves, traps and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect and/or Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect and/or Construction Manager.

1.5 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.6 Record Drawings

A. Maintain a separate set of prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work and within 90 days of system acceptance, these drawings shall be turned over to the Architect and/or Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.7 Operating and Maintenance Manuals

A. Assemble three copies each of operating and maintenance manuals for the Plumbing work.

B. All "approved" shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Pipe pressure test reports, domestic water disinfection certificate of completion and bacteriological analysis results shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

1.8 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect the work and develop their own punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.9 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during this warranty period shall be made good without expense to the Owner. Use of equipment for temporary system use is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and/or labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as re-tightening or repacking glands, greasing, oiling, belt tightening and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

All equipment and appliances shall be listed and labeled in accordance with the Plumbing Code. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance

2.3 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe or equipment layout, or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.5 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection

and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following Plumbing equipment and materials shall be submitted:

1. Pipe, fittings and joining methods for the various systems.
2. Pipe hangers and supports.
3. Valves.
4. Gauges.
5. Pipe insulation.
6. Drainage structures (Master Trap / Solids Interceptor).
7. Gas pressure regulator and meter setting.
8. Gasoline Tanks, Pumps, Dispensers, and associated devices.
9. Supply system specialties.
10. Backflow preventers.
11. Drainage system specialties.
12. Plumbing fixtures and trim.
13. Water heating equipment.

PART 3 - EXECUTION

3.1 Pipe Testing

A. All piping provided in this work shall be pressure tested, as specified below.

B. Pipe testing for Plumbing piping shall be:

1. Underground domestic water service - hydrostatic at 125 psig or 1.5 times the maximum operation pressure, whichever is higher, for 6 hours, and in conformance with AWWA procedures.
2. Domestic cold and hot water piping - hydrostatic at 125 psig or 1.50 times the maximum operation pressure of the system, whichever is higher, for 6 hours at the low point of the system.
3. Soil, waste and vent piping and storm piping - rough test and final test, in conformance to Plumbing Code requirements.
4. Interior natural gas piping - 25 psi compressed air for 4 hours. .
5. Other piping - refer to appropriate Sections.

C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

F. Where a new pipe connects to an existing pipe, provide the following to facilitate testing, cleaning, draining and eventual shutoff service:

1. A shutoff valve in the new pipe near the point of connection.
2. A valved stub with brass plug downstream of the valve for testing of the new pipe extension. Close valve, remove handle after testing is complete. Wire handle to valve body.

3.2 Pipe Cleaning

A. Before placing each water piping system in operation, the piping system shall be thoroughly flushed out with clean water. Remove, clean and replace all strainer screens once flushing is complete. On domestic water systems, remove, clean and replace all fixture mounted strainer screens and faucet aerators after fixtures are set and connected piping is flushed thru the fixtures.

B. Refer to appropriate Sections for cleaning of other piping for normal operation.

3.3 Disinfection of Piping

A. All new domestic water systems shall be disinfected by a company or personnel regularly engaged in the performance of this service.

B. Keep new systems isolated from the service systems until after disinfection is completed and proven acceptable by bacteriological test results. Provide a service cock at the water service entrance for injection of the disinfecting agent. If it is necessary to use a potable water supply in the performance of the disinfection procedures, provide temporary reduced pressure zone back flow prevention until disinfection and analysis results are complete.

C. Thoroughly flush the system, as previously described, prior to disinfection. Disinfection shall be performed in accordance with the Local Authorities prescribed method, or when a Local Authority prescribed method is not available, in accordance with the locally adopted Plumbing Code or AWWA C651 or AWWA C652 Standards. Disinfection shall be by means of a chlorine solution injected into the water system near the source. Each outlet shall be tested to prove presence of minimum chlorine concentration. Document that adequate levels of chlorine are present in all parts of the system. Following the appropriate retention period, flush out the system with clean water until the residual free chlorine content is equal to the level of the incoming water, but not greater than 1.5 parts per million or until approved by the Health Department.

D. Perform a bacteriological analysis of the potable water system in compliance with Health Department requirements. One test sample shall be collected from the end of the main and one from each branch. Provide certification stating the name of the lab performing the testing, the job name, the date of the sample and results of the testing.

E. Contractor shall inform the Owner in advance of disinfection procedures so that the Owner might have a representative witness the procedure. . Certified laboratory information and bacteriological analysis reports shall be included in the Operations and Maintenance Manuals.

F. Domestic water systems shall be disinfected and bacteriologically analyzed within 14 days of the established date of substantial completion. Systems disinfected and analyzed more than 14 days prior to substantial completion shall be disinfected and analyzed again, or an Owner approved total system flushing procedure shall be implemented.

3.4 Operation and Adjustment of Equipment

A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing water systems, tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

C. Test relief valves, air vents and regulating valves to ensure proper operation.

3.5 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. For each piece of plumbing equipment and for systems, where designated in other sections of Division 22, the respective equipment manufacturer shall provide a qualified representative to demonstrate the operation, maintenance and service requirements of the equipment and/or system. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings. At the completion of the demonstration present a demonstration certificate to the Owner for signature. A copy of the certificate shall be sent to the Architect / Construction Manager.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

END OF SECTION

22 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's / and / Engineer's / and / any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies

in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

ELECTRONIC FILES
HEAPY RELEASE FORM TO CONTRACTORS

Project: GDRTA Bus Garage and Wash

Dayton, Oh

Owner: GDRTA

Heapy Engineering Project Number: 2023-07202

Heapy Engineering Project Manager: Don Timmer

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

    b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

    c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

    d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

Provider (Name of Company): _____

Recipient (Name of Company): _____

Recipient Address: _____

Name of authorized Recipient Representative: _____

Title of authorized Recipient Representative: _____

E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ CD-ROM ☐ DVD-ROM ☐ Heapy FTP ☐ User's FTP site ☐ Flash Drive

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 20XX DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG
Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 22 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.
Available electronic Revit file format:
☐ 20XX .RVT

Cost of Preparation of Division 22 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

22 05 04 BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Construction Water New Building

A. Refer to Division 01 - General Requirements, for information regarding construction water.

B. Install the new water service as soon as practicable to facilitate water supply for construction purposes. Provide a water meter, piping and hose bibbs with vacuum breaker at the site as directed by the General Contractor / Construction Manager. Protect meter and piping from physical damage and freezing.

C. Cost of water use for construction is not included in Division 22.

D. Remove construction water meter and piping when no longer required.

1.2 All piping, fittings, valves, solders, fluxes, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

1.3 Continuity of Services

A. Work shall be so planned and executed as to provide reasonably continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch-over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdown shall be bid as being done outside of normal working hours.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devise and equipment requiring service or adjustment. Refer to Section 22 13 19 Drainage System Specialties for access plates associated with cleanouts.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock / tamperproof screws / industrial grade lock set. Locks in “secured” areas of the building shall have tamperproof screws / be institutional grade locksets. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.
2. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Milcor Style “ATR” or equal.
3. Standard flush type for drywall ceilings and walls, Milcor Style “M” or equal.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required. Panels shall be equal to Chicago Metallic Model CRG.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Plumbing work shall be performed by licensed Plumbing Contractors in accordance with requirements of the jurisdiction.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager. All piping and tubing shall be elevated from grade for on-site storage, and all open ends shall be covered. Plastic piping shall be protected from direct and indirect sunlight.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas. Work shall be conducted in strict adherence to the facility Construction and Renovation Infection Control Standards.

3.3 Cutting and Patching New Buildings

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where pipes are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange for the provision of openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work. Any damage caused to the building in this work shall be repaired or rectified.

C. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

3.4 Painting

A. In addition to any painting specified for various individual items of equipment, provide the following painting:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite / 221 cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.

B. Paint, surface preparation and application shall conform to the paint manufacturer's instructions / applicable portions of the Painting section of Division 09 Specifications. All rust must be removed before application of paint.

C. Provide finish painting only where specifically instructed. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.5 Access Panels

A. Install access panels. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

END OF SECTION

22 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and pipe layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the OBC / Chapter 1, and Chapter 7, and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of UL firestopping assemblies and installation instructions. Submittals shall include all information required in the OBC / Chapter 1, and Chapter 7.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 22 05 07 Piping Materials and Methods for Plumbing for pipe sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION

22 05 07 PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Piping materials and methods for piping common to Division 22 – Plumbing shall be as specified herein and as shown on the drawings.

1.2 All piping, fittings, valves, solders, fluxes, seals and appurtenances in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

1.3 Included in this section are:

A. Pipe, fittings and joining methods.

B. Unions and flanges.

C. Dielectric connectors.

D. Pipe sleeves, openings, curbing and escutcheons.

E. Installation methods of piping.

1.4 Refer to other Sections in Division 22 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.5 Refer to Section 22 05 05 Firestopping for firestopping requirements.

1.6 Pipe welding procedures, testing and welders performance shall comply with The American Welding Society Welding Handbook, AWS B2.1 and D10.11, D10.12 and National Welding Institute.

1.7 Pipe threads shall meet B1.20.1 for factory threaded pipe and pipe fittings.

1.8 Soldering procedures per ASTM B828 with flux per ASTM B813 and solder per ASTM B32.

1.9 Solvent cement joints for PVC per ASTM D-2855, primer per ASTM F656.

1.10 Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to this trade in new walls, partitions, floors and roof slabs, same as for new piping.

1.11 Pipe sleeves shall be provided where below grade pipes penetrate foundation walls. Relieving arches shall be provided for all below grade pipes passing below structural footings.

1.12 Sleeves are not required:

A. In floor slabs on grade.

B. In stud and gypsum board or plaster walls and partitions which are not fire rated.

C. For above grade uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.

D. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.

E. In large floor openings for multiple pipe risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after pipes are set.

1.13 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 Copper tubing, conforming to ASTM B88, Standard Specification for Seamless Copper Water Tube and Fittings and Joints, shall be:

A. Type C1
Pipe - Type "L" seamless hard drawn copper tubing.
Fittings – ASME B16.22 wrought copper or cast bronze, solder ends.
Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin in accordance with methods of ASTM B828 and equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

B. Type C2
Pipe - Type "L" seamless hard drawn copper tubing.
Fittings – ASME B16.22 wrought copper or cast bronze, solder ends.
Joints - brazed with 15 percent silver brazing alloy equal to Harris "Stay-Silv 15" or Harris "Dynaflow". Brazing filler shall meet AWS A5.8.

C. Type C3
Pipe - Type "K" soft copper tubing.
Fittings – ASME B16.22 wrought copper, solder ends.
Joints - brazed with 15 percent silver brazing alloy equal to Harris "Stay-Silv 15" or Harris "Dynaflow". Brazing filler shall meet AWS A5.8.

D. Type C6
Pipe - Type "L", 0.5 inches thru 4 inches seamless hard drawn copper tubing.
Fittings – copper or cast bronze press fittings conforming to ASME B16.51 and ASME B16.22, EPDM O-ring seal. O-ring seal and/or seal cup design must not allow the fitting joints to pass a pressure test prior to being pressed.
Joints – 200 psi, 250 degrees F rated compression joint using fitting manufacturer approved electro-hydraulic crimping tool. Compression crimp shall be applied on upstream and downstream side of EPDM seal bead.

E. Mechanically formed extruded outlets in copper tubing may be provided in lieu of standard tees and couplings. Mechanical formed extruded outlets shall be in compliance with ASME B31.9, Section 930.2, constructed perpendicular to the axis of the run tube and formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height three times the thickness of the branch wall. The inner branch tube end shall conform to the shape of the inner curve of the run tube, and the insertion depth shall be controlled so that the branch tube does not extend into the flow stream. All joints shall be brazed. All installation tools and procedure shall be by a single manufacturer. Mechanically formed tees and couplings shall be T-Drill or approved equal. Unions and flanges shall be:

A. Unions on copper tubing, all bronze construction 150 lb., solder ends.

B. Unions on steel pipe 2 inches and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

C. Flanges on steel pipe with welded or screwed joints, 2.50 inches and larger. Gaskets shall be 0.0625 inch thickness, ASME B16.21, full face compressed sheet suitable for temperature and pressure ranges of the application.

D. Unions on plastic pipe, same composition and pressure rating as the piping system.

2.2 Pipe sleeves shall be:

A. Schedule 40 black steel pipe, ASTM A53, Type E, Grade A or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.

B. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

C. Combination pre-set floor sleeve and firestopping assembly equal to Hilti CP 680. Refer to 22 05 05 Firestopping.

2.3 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Mechanically formed tee fittings and couplings of the T-Drill type on copper tubing shall be formed in a continuous operation using equipment specifically designed for the application in strict adherence to the manufacturer's instructions. Cutting debris shall be removed from the piping on completion. Joints shall be brazed.

3.3 Press connections: Copper press fittings shall be made in accordance with the manufacturers installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing if fully engaged (inserted) in the fitting. The joints shall be made using a calibrated tool approved by the manufacturer.

3.4 Piping shall be pitched for drainage. The low points shall be fitted with a 0.75 inch drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1.25 inches and smaller where a drain valve is not shown, a drain plug is acceptable.

3.5 Piping shall be installed consistent with good piping practice, run concealed wherever possible and located as to be protected from damage by freezing. Coordinate with other trades to attain a workmanlike installation.

3.6 Piping shall be supported as specified in Section 22 05 29 Hangers and Supports for Plumbing Piping. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.

3.7 Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering.

3.8 Installation of plastic piping shall be in full compliance with manufacturer's recommendations and code requirements, with specific consideration given to expansion compensation and pipe hanger spacing. Plastic pipe is not permitted in air plenum spaces.

3.9 Close open ends of piping during installation to keep interior of the pipe clean.

3.10 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the NEC.

3.11 Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposes. A union shall be installed at each threaded shut-off valve on the side of the valve for which shut-off service is intended.

3.12 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect.

3.13 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water, refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.14 Refer to 22 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.15 In lieu of firestopping and where permitted by the OBC, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar) in compliance with ASTM E 119 test requirements.

3.16 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with sealant or caulking to retard the passage of noise or smoke. Sealant or caulking shall be applied per the manufacturer’s requirements, including opening width limitations, backing materials, sealant or caulking thickness, etc. Sealants and caulking shall be compatible with the materials they are in contact with, and sealants and caulking in direct contact with copper piping shall be silicon-based to minimize the potential for corrosion.

END OF SECTION

22 05 09 EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 Excavate for all in-grade underfloor piping, underground exterior piping, underground tanks and associated incidental work. Backfill to finish grade or to levels consistent with site work activity. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition or as is consistant with site activity.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.

1.3 Contact the Ohio Utilities Protection Service (1-800-362-2764 or 811) / and the Oil and Gas Producers Underground Protection Service (1-800-925-0988 or 811) sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 A utility locator service shall be provided to locate, mark and identify private lines and other utilities that are not located by the means mentioned above.

1.5 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31 Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Trenches for interior and exterior piping shall be over excavated and the pipe shall be laid on 6 inches minimum depth sand bed.

3.2 Backfilling and compaction of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with approved backfill materials, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials up to 18 inches above the top of the piping. The remainder shall be with similar materials or with excavated material having no large clods, stones or rocks.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of. Refer to Division 31 Earthwork for compaction requirements.

3.4 Plastic piping for sewers and drain shall be installed in compliance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-flow Applications.

3.5 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions. Refer to Division 32 for Exterior Improvement requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.

3.6 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included so that no additional cost will accrue to the Owner.

3.7 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.8 All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the pipe.

END OF SECTION

22 05 19 METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 Thermometers and pressure gauges shall be provided as shown on the drawings and as specified herein.

1.2 Meters related to combination balancing - shutoff valves are specified in Section 22 05 23 – General Duty Valves for Plumbing Piping.

1.3 Gauges and meters furnished as a part of factory assembled equipment are specified with such equipment.

1.4 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing portable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Manufacturers products listed below are basis of design. Other acceptable manufacturers are Winters, Milijoco or Palmer Instruments.

2.2 Thermometers

A. Thermometers shall be 4.5 inches diameter dial face, vapor actuation type with aluminum case, glass lens, adjustable angle hinge, stainless steel insertion stem and adjustable pointer equal to Trerice V80742 with 316 stainless steel thermowell.

B. Separable socket insertion well, with graphite fill, shall be furnished with each thermometer. An extension neck socket, with appropriate increase in thermometer stem length, shall also be furnished where insulation thickness exceeds 2 inches.

C. Ranges of thermometers shall be selected to be consistent with anticipated temperatures. Select thermometer so that the normal operating temperature is near mid-range of the thermometer, example chilled water (45 degrees F) thermometer range 0 - 100 degrees F.

2.3 Pressure Gauges

A. Pressure gauges shall be Bourdon tube type with 4.50 inches dial and cast aluminum case, equal to Trerice 600CB-PBF Series. Accuracy shall be 1 percent at mid-range.

B. Pressure gauges for low pressure application, 4” diameter, calibrated in inches of water gauge, ounces per sq. in. or 0 - 5 psi, as appropriate, shall be equal to Trerice 760B.

C. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.

D. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

PART 3 - EXECUTION

3.1 Thermometers shall be installed where shown on the drawings and also at:

A. Each water heater.

3.2 Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:

A. The incoming water service; the incoming gas service; downstream of the reduced pressure backflow preventer; inlet of each water heater.

3.3 Thermometers and gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.

3.4 Install thermometer wells in piping tees in the vertical position. Fill the well with graphite and secure the thermometer in position.

END OF SECTION

22 05 23 GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 Refer to Section 22 11 16 Interior Domestic Water Piping and Section 22 11 19 Interior Domestic Water Piping Specialties for selection of valves for the various services. Valves peculiar to individual systems are referenced or specified in Sections related to those systems.

1.2 Valves and materials shall comply with applicable standards and specification of ANSI, ASTM, ASME and MSS. Working pressure and temperature ratings of each valve shall exceed those imposed by the service in which it is applied.

A. ASTM B584 and ASTM B61 Copper Alloy Sand Casting for General Applications.

B. ASME B16.10, MSS SP-67 Butterfly Valves.

C. MSS SP-70 Cast Iron Gate Valves, Flanged or Threaded Ends.

D. MSS SP-80 Bronze Gate, Globe and Check Valves.

E. MSS SP-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

F. ASME B16.34, MSS SP-110 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

G. Bronze (brass) valves installed in drinking water systems made with copper silicon alloy shall contain less than 22 percent zinc, and made with copper bismuth alloy less than 4 percent zinc. Bronze (brass) valves installed in non-drinking water systems shall contain less than 15 percent zinc.

1.3 All piping, fittings, valves, solders, fluxes, seals, fixtures, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Valves installed in potable and drinking water systems shall be:

A. Ball Valves – NIBCO, Apollo, Milwaukee, Watts, Legend, Crane, Marwin

1. Type B1. 2 inches and smaller. 2 piece, non-repairable
NIBCO T 585-80/66-LF, 150 s.w.p., 600 w.o.g., two piece bronze body, ASTM B584 screwed ends, full port, bronze / stainless steel ball and stem, packing nut with adjustable stem packing, TFE seat and seal, handle.

2. Type B2. 2 inches and smaller. 3 piece, repairable
NIBCO T 595-Y-66-LF, 150 s.w.p., 600 w.o.g., three piece bronze body, ASTM B584 screwed ends, stainless steel ball and stem, full port, packing nut with adjustable stem packing, TFE seat and seal, handle.

3. Type B4. 2.50 inches and larger.
Watts G-4000-FDA or American 3700, 200 c.w.p., two-piece fused epoxy coated cast iron body (inside and out), flanged ends, stainless steel or PFA fused cast iron ball and stainless steel stem, full port, PTFE seat and seal, handle.

B. Check Valves – NIBCO, Milwaukee, Stockham, Watts, Legend, Crane

1. Type C1. 2 inches and smaller — Swing check
NIBCO T 413-Y-LF, 125 s.w.p., 200 w.o.g., bronze body (ASTM B584), screwed ends, renewable bronze swing disc with TFE seat ring.

2. Type C2. 2.50 inches and larger. — Swing check
Val-Matic Series 7800 or approved equal, 250 c.w.p., ductile iron body, NSF/ANSI 372 interior and exterior fused bonded epoxy coating, flanged ends, renewable iron swing disc and aluminum bronze seat.

3. Type C3. 2 inches and smaller. — In-line spring
NIBCO T 480-Y-LF, 250 w.o.g., in line spring actuated center guided silent check, inline lift type, bronze body, screwed ends, TFE disc and seat ring.

4. Type C4. 2.50 inches and larger. — In-line spring
Val-Matic Series 1400 A or approved equal, 200 c.w.p., in line spring actuated center guided silent check, wafer style, iron body for installation between flanges, NSF/ANSI 372 interior and exterior fused bonded epoxy coating, bronze seat and disc.

2.2 Valves installed in non-potable and non-drinking water systems shall be:

C. Ball Valves - NIBCO, Apollo, Milwaukee, Watts, Legend, Crane

1. Type B3. 2.50 inches and 3 inches. — 2 piece, non-repairable
NIBCO T 580 70-66, 150 s.w.p., 600 w.o.g., two piece bronze body, ASTM B584 screwed ends, 316 stainless steel ball and stem, standard port, packing nut with adjustable stem packing, reinforced TFE seat and seal, handle.

2. Type B4. 2.50 inches and larger.
Watts G-4000-FDA or American 3700, 200 c.w.p., two-piece fused epoxy coated cast iron body (inside and out), flanged ends, stainless steel or PFA fused cast iron ball and stainless steel stem, full port, PTFE seat and seal, handle.

3. Type B5. 2 inches and smaller. — 2 piece, non-repairable
NIBCO T-585-70-66, 150 s.w.p., 600 w.o.g., two piece bronze body, ASTM B584, screwed ends, full port, chrome plated brass ball and bronze stem/stainless steel ball and stem, packing nut with adjustable stem packing, TFE seat and seal, handle.

4. Type B6. 2 inches and smaller. — 3 piece, repairable
NIBCO T 595-Y-66, 150 s.w.p., 600 w.o.g., three piece bronze body, ASTM B584 screwed ends, stainless steel ball and stem, full port, packing nut with adjustable stem packing, TFE seat and seal, handle.

D. Check Valves – NIBCO, Milwaukee, Stockham, Watts, Legend, Crane

1. Type C2. 2.50 inches and larger. — Swing check
NIBCO F-918-B, 125 w.s.p., iron body, bronze trim, flanged ends, renewable bronze swing disc and seat ring.

2. Type C4. 2.50 inches and larger. — In-line spring
NIBCO F 910-B, 200 w.w.p., in—line spring activated center guided silent check, globe style, flanged ends, renewable bronze seat and disc.

3. Type C5. 2 inches and smaller. — Swing check

NIBCO T 473 B, 300 s.w.p., 600 c.w.p., Y pattern, bronze body, screwed ends, renewable bronze swing disc and seat.

4. Type C7. 2 inches and smaller. Swing check
NIBCO T 413-Y, 125 s.w.p., 200 c.w.p., bronze body (ASTM B62), screwed ends, renewable bronze swing disc with TFE seat ring.

5. Type C8. 2 inches and smaller. In-line spring
NIBCO T 480-Y, 125 s.w.p., 250 w.o.g., in line spring actuated center guided silent check, bronze body, screwed ends, PTFE disc and seat ring.

2.3 Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends. Valves of equal construction and features with ends compatible with grooved end pipe mechanical joint couplings are acceptable on such systems, and may be manufactured by the coupling system manufacturer.

2.4 Ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation. On cold service piping, the extended shaft neck design shall permit operation of the valve without breaking the vapor seal.

PART 3 - EXECUTION

3.1 Drain valves shall be the same as for shutoff service. Provide a 0.75 inch hose thread adapter on the outlet of each drain valve that is not piped to a drainage point.

3.2 Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing.

3.3 Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.

3.4 Packing glands shall be tightened before placing the valves in service.

END OF SECTION

22 05 29 HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 All interior piping shall be supported from the building structure.

1.2 All products and assemblies installed with-in a plenum shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other approved equal manufacturers are B-line, Erico, Mason, PHD and TOLCO.

2.2 Hangers and supports for horizontal piping shall be equal to:

A. General service - clevis type Anvil Fig. 260.

B. Uninsulated copper tubing - copper plated clevis type - Anvil Fig. CT-65 (or plastic coated clevis).

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis and trapeze type hanger.

Pipe Sizes	Min. Rod Dia.
2” and smaller	0.375"
2.5” to 3"	0.50"
4” to 5"	0.625"
6” to 8”	0.75”

2.4 Where the length of the hanger rod between the top of the hanger and the attachment device is 3 inches or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel.

2.5 Hanger rod attachment devices for attachment to the structure shall be:

A. Pre-set concrete inserts.

B. After-set steel expansion type concrete inserts.

C. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

D. Channel support systems equal to Unistrut or Hilti.

E. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.6 Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension. Piping 1” and smaller and specified to be insulated with elastomeric type insulation

may utilize Anvil's 25/50 flame/smoke rated Klo-Shure strut-mounted TPO plastic insulation couplings with steel strut clamp. Insulation wall thickness shall be 0.75" thickness. Transition to required service insulation thickness within 2" of either side of coupling.

2.7 Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, provide sheet metal shields and insulation inserts as specified in 22 07 19 Plumbing Piping Insulation.

2.8 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.9 Coordinate the items above during the bidding period and determine, consistent with industry practice, the selection, furnishing and installation of the needed components.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as follows; unless otherwise shown on drawings:

A. Steel pipe (vertical) - at the base, at each floor level, and 15 ft. maximum spacing.

B. Steel pipe (horizontal) - 7 ft. intervals for piping 1.5 inches size and smaller, 10 ft. spacing for piping 2 inches thru 6 inches, 12 ft. spacing for larger pipe.

C. Copper tubing (vertical) - at the base, at each floor level; and 10 ft. maximum spacing.

D. Copper tubing (horizontal) - 6 ft. spacing for tubing 1.25 inches size and smaller, 8 ft. spacing for 1.50 inches thru 2.5 inches sizes, 10 ft. spacing for tubing 3 inches size and larger.

E. Cast iron pipe (vertical) - at the base and at each floor (15 ft. maximum spacing).

F. Cast iron pipe (horizontal) - at each fitting and at each joint on straight lengths, 10 ft. maximum spacing.

G. Plastic Pipe - spacing and hanging methods in strict accordance with code requirements and manufacturer's recommendations, with consideration being given to service temperature and expansion compensation, but no greater than 4 feet spacing for horizontal and no greater than 10 feet spacing for vertical piping (with midstory guide).

3.2 Attachment of pipe hangers to the structure shall be with:

A. Pre-set concrete inserts in concrete construction of 4 inches minimum depth.

B. After-set concrete inserts, in 4 inches minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.

C. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment. Attachment to bar type joists shall be at joist panel points only.

D. In fabricated steel joist construction (bar joists) attachment of hanger rods shall be through the gap of the joist chord angles so that loads are concentrically applied to the steel joist in accordance with the rules of the Steel Joist Institute and the Architect/Structural Engineer.

E. Unistrut type channel support system may be utilized where a number of pipes are run parallel or to span below other utilities and equipment. Channel shall be pre-set or attached to the structure with inserts or clamps.

F. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

G. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

3.3 The first two hangers on piping connecting to both the suction and discharge of motor driven equipment shall be fitted with steel spring and neoprene isolators.

3.4 Pate style support curbs shall be attached to the roof deck and flashed into the roofing system.

3.5 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.6 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.7 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer

END OF SECTION

22 05 53 IDENTIFICATION OF PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 Identification of plumbing equipment shall consist of equipment labeling, pipe marking and valve tagging as specified hereinafter.

1.2 Each item of major equipment shall be labeled. This shall include or compressors, pumps, vacuum pumps, water heaters, tanks, and other similar equipment.

1.3 Pipe markings shall be applied to all piping.

1.4 Underground exterior piping shall be identified with a continuous plastic line marker tape as described in the service piping sections and this section.

1.5 Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled typewritten on 8.50 inches x 11 inches paper, tabulating valve number, piping system, system abbreviation, location of valve (room or area) and service (e.g. - south wing cold water).

1.6 Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

1.7 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.8 Coordinate pipe markings and valve tags to ensure similar markings.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

B. Stencil painted identification, 2 inch high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Pipe markings shall be:

A. Plastic semi-rigid snap-on type, manufacturer's standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl markers similar to the above.

B. On piping and insulation 6 inches and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1.50 inches wide, full circle at both ends of the marker.

C. Arrows for direction of flow provided integral with the pipe marker or separate at each marker.

2.3 Underground line marker tape shall be permanent bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.4 Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with "P" (for plumbing) and the designated number.

2.5 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after insulation and painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in Division 22 identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Division 21, 22 and 23 labeling, marking and tagging shall be coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings.

3.5 Pipe markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces.

C. At 50 ft. centers in exposed finished area locations.

D. On mains at each branch take-off.

E. At least once in each room.

3.6 Refer to appropriate sections of this specification for installation of underground line marker tape.

3.7 Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above. Copies of one set of schedules shall be laminated in clear plastic and placed where directed by the Owner. Other sets shall be included in the Operating and Maintenance Manuals.

END OF SECTION

22 07 19 PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 Piping systems shall be insulated as described below. Pipe, fittings, unions, flanges, valves, devices, specialties and related items in the piping systems shall be insulated unless otherwise noted, with access maintained to P/T test ports, strainer caps, air vents and similar accessories thru the use of removable and reusable caps, plugs and fittings.

1.2 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 243 listed in lieu of UL 723 or ASTM E84.

1.3 Insulation thicknesses are based on ASHRAE 90.1 and an average thermal conductivity of 0.22 to 0.28 BTU-in./hr. ft.2 - degrees F at 100 degrees F (0.21 to 0.27 BTU-in/hr ft^2 – degrees F at 75 degrees F). Thickness of insulation with lower conductivity may be reduced proportionately except that minimum thickness shall be 0.50 inch.

1.4 The following plumbing piping shall be covered with insulation of thickness listed, in compliance with ASHRAE 90.1, latest publication:

Pipe System	0.75” and smaller	1.0” to 1.25”	1.50” to 3”	4” to 6”	8” and larger
Domestic cold and non-potable water	0.50”	0.50”	1”	1”	1”
Domestic hot water (≤140°F)	1”	1”	1.50”	1.50”	1.50”
Storm drainage (1)	-----	-----	1”	1”	1”

Notes:

1. Storm and secondary (emergency) roof drainage systems - interior horizontal above ground piping including underside of roof drain sumps and outlet piping.

1.5 Insulation on plumbing systems is to be omitted on the following:

A. Unions in domestic hot water piping systems.

B. Exposed plumbing fixture supplies and supply stops except where required to meet ADA requirements.

C. Exposed chrome plated piping and pipe line devices in kitchens, laboratories, etc.

D. Vertical interior storm drainage piping (downspout), except the first vertical section at the outlet of the roof drain sump and as noted above.

1.6 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.7 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Fiberglass insulation shall be manufactured by Johns Manville, Owens-Corning, Knauf or Manson. Closed-cell elastomeric insulation shall be manufactured by Armacell, K-Flex USA "Insul-Tube" or Aeroflex USA "Aerocel-SSPT". Refer to paragraphs below for manufactures of specific restricted use insulations.

2.2 Fiberglass pipe insulation shall be factory molded tubular fiberglass with "all service" jacket having an integral vapor barrier. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6 inch centers may be used with vapor barrier mastic applied to seal both the joint and stable holes. Butt joints shall be sealed with 3 inches wide ASJ pressure sensitive tape. Insulation shall be GreenGuard certified for low formaldehyde and VOC emissions.

2.3 Closed-cell elastomeric insulation shall be tubular or sheet form, flexible pipe insulation. Polyolefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC's, HCFC's or HFC's. It should meet ASTM C534 and also be formaldehyde free, low VOC and resistant to mold and mildew. Pre-slit longitudinally with pressure sensitive adhesive tape closure system on tubular systems up to 4 inches IPS pipe size, field-split adhesive-seal on tubular systems for 6 inches IPS pipe size and self-adhering sheet insulation for pipe sizes larger than 6 IPS. Joints which do not have factory-applied sealant shall be sealed with 2 inches wide elastomeric thermal insulation tape or low VOC vapor sealing adhesive, complying with the specifications of the insulation manufacturer. Installation shall be in accordance with the manufacturer's published installation instructions.

For indoor systems, use shall be restricted to those systems requiring 1.5 inch thickness or less (due to 25/50 ASTM E84 requirements).

Unless jacketed, for insulation located outside, field paint with minimum (2) coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

2.4 Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:

A. For fiberglass insulation systems:

1. Factory molded fitting insulation cover with PVC one-piece fitting cover;
2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover;
3. Fiberglass blanket insulation, compressed, held in place and covered with PVC one-piece fitting cover; or
4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.

B. For closed-cell elastomeric insulation systems:

1. Miter cutting of tubular insulation using special tools and mitering devices; or
2. Oversized pipe insulation and insulation donuts, overlapped and shaped to conform to the fitting, valve or device.

2.5 Hangers on insulated horizontal piping are to be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:

A. Pipe 2 inches and smaller - Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12 inches long.

B. Pipe 2.50 inches and larger.
Pipe service temperatures 210 degrees F and below: 360 degrees insulated saddles equal to Buckaroos Tru-Balance with phenolic foam insulation, integral zero-perm vapor barrier and sheetmetal rib-lock shield with belled ends. For piping systems specified to be insulated with elastomeric type insulation, utilize Armafex IPH 25/50 flame/smoke rated insulation pipe hangers with polyurethane inserts and 30 MIL aluminum jacket, insulation wall thickness shall be minimum 1". If required service insulation is specified to be greater than 1", transition to required thickness within 2" of either side of IPH.

2.6 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

1. Due to condensation issues, fiberglass insulation shall not be installed until building is covered and conditioned.

C. Ensure that pressure testing of piping and fittings has been completed prior to installation.

3.3 Installation

A. Installation shall be done by tradesman specializing in insulation work in strict accordance with manufacturers' recommendations. Installers shall be factory trained and certified for the insulation systems being installed. Submit credentials upon request.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices.

C. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal, including over staples.

D. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic, except in cellular glass systems. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.

E. Vapor barrier shall be continuous on insulation of all cold services, including horizontal storm and overflow drains. Vapor barrier type mastic shall be used where needed to maintain a vapor seal. Overlap and seal all longitudinal joints of fiberglass insulation jacket. Staples and adhesive may be used as stated above. Tape and seal cross joints.

F. Insulation on cold service piping shall be run thru floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the 22 05 07 Piping Materials and Methods for special considerations which must be given at fire rated wall and floor penetrations. Refer to Section 22 05 23 General Duty Valves for Plumbing Piping for valves requiring extended shaft necks. Coordinate the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.

G. The underside of roof drain sumps / bearing pans shall be insulated with self-adhering sheet form closed-cell elastomeric insulation, securely adhered to the underside. All joints shall be adhesive sealed, vapor-tight, to minimize the potential for condensation forming. Blanket type fiberglass insulation shall not be used.

3.4 Protection

A. Advise as to the requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

END OF SECTION

22 10 10 FACILITY GAS PIPING

PART 1 - GENERAL

1.1 Natural gas service to the building shall be provided complete with piping, valves and devices, excavation, backfill and surface restoration and installation of Gas Company furnished meter and pressure regulator. Additionally gas service shall be provided from the bus garage below grade to the bus wash out building per drawings.

1.2 Gas meter and pressure regulator installation will be provided by the Gas Company.

1.3 Materials, installation and pressure testing methods shall be in conformance with Gas Company regulations and requirements and those of other governing authorities.

1.4 Bidders shall be a fully qualified installer to perform “covered” tasks as required by the DOT and PUCO Operator Qualification Rule and shall be listed as a qualified contractor of the servicing gas company.

1.5 Verify with the Gas Company location of connection and gas pressure and meter and pressure regulator installation details. Apply for and pay permit and other fees associated with the gas service work.

1.6 Refer to 22 05 09 Excavation, Backfill and Surface Restoration and 22 10 12 Interior Gas Piping.

PART 2 - PRODUCTS

2.1 Pipe and Fittings

A. Plastic - Polyethylene, 4710 Type III Grade 3, conforming to ASTM D2513. Fittings shall be molded polyethylene. Joints shall be butt heat-fusion type conforming with ASTM D3261.

B. Piping above grade shall be Schedule 40 black steel. Pipe risers from below grade shall be steel, coated for underground service. Prefabricated coated steel riser(s) approved by the Gas Company may be provided at the meter and regulator setting and at the building walls.

C. Service piping materials shall conform to Gas Company requirements. Verify materials selected are in conformance before installation.

2.2 Above ground valves.

A. Lubricated plug valve. Nordstrom, Homestead, DeZurik, Durco, Newman-Milliken.
Iron body, 200 psi. Nordstrom No. 142 (2 inches and smaller, threaded ends) and No. 143 (2.50 inches and larger, flanged ends).

B. Ball valves. Hammond, Nibco, Milwaukee, Watts, Apollo.
2 inches and smaller. Hammond 8901, 600 psi non-shock WOG, two-piece forged brass body, screwed ends, brass stem and ball with chrome plating, reinforced TFE seat and seal, handle.

C. Locking feature shall be incorporated on valves where so designated, or where directed by local gas company.

PART 3 - EXECUTION

3.1 Service piping shall be buried with a minimum of 30 inches cover. Lay a copper tracer wire over plastic service pipe as directed by the Gas Company.

3.2 Excavation, backfill and surface restoration shall conform to 22 05 09 Excavation, Backfill and Surface Restoration. Bedding, pipe installation and backfill around the pipe shall conform to Gas Company and pipe manufacturer's recommendations.

3.3 Provide a concrete pad, protective steel pipe bollards set in and filled with concrete and painted, as shown and as directed by the Gas Company, in conjunction with the meter and regulator setting.

3.4 Provide a sealed wall sleeve at the service entrance to prevent gas leaks from entering the building.

3.5 Underground and above ground piping shall be pressure tested in accordance with Gas Company regulations. Test and metering - recording equipment shall be provided by the Contractor.

3.6 Underground steel pipe fittings, joints and breaks in the pipe coating shall, after final testing, be coated with 0.625 inch thickness of Barretts pipe enamel or double wrapped with "Tape Coat". Underground steel pipe shall be protected with anodes as directed by the Gas Company.

3.7 Purging of fuel gas piping shall be conducted in accordance with the criteria and procedures outlined in the International Fuel Gas Code for the opening of existing piping systems and/or the placing of new or revised piping systems in operation.

END OF SECTION

22 10 12 INTERIOR GAS PIPING

PART 1 - GENERAL

1.1 Piping, valves and associated devices and materials for the interior fuel gas system shall be provided as shown on the drawings and as specified.

1.2 Materials and installation shall conform to standards and requirements of the Gas Company, International Fuel Gas Code and NFPA 54 National Fuel Gas Code. Welders shall be certified.

1.3 Refer to 22 05 07 Piping Materials and Methods for Plumbing, 22 05 23 General Duty Valves for Plumbing Piping, 22 05 29 Hangers and Supports for Plumbing Piping and other appropriate sections for applicable provisions relating to work in this Section.

PART 2 - PRODUCTS

2.1 Gas piping in shall be Schedule 40 black steel ASTM A-53 Types E and F. Fittings shall be steel welding type and threaded malleable iron or consistent with joint requirements. Joints shall be welded except that threaded joints are permitted:

A. On threaded valves and unions.

B. At final connections to equipment.

C. On piping 1.25 inches and smaller carrying gas at 1 psi and less. Refer to Paragraph 3.1.

2.2 On piping 4 inches and smaller carrying gas at 5 psi and less, gas piping, at the contractor's option, shall be Schedule 40 black steel ASTM A-53 Types E and F. Fittings conform to ASTM F3226, ANSI LC4a/CSA 6.32a, ASME B31.9.

A. Fittings shall be press fitting with HNBR natural gas compatible sealing elements that are factory installed.

B. Seal and/or seal cup design must not allow the fitting joints to pass a pressure test prior to being pressed.

C. Compression joint shall use fitting manufacturer approved electro-hydraulic crimping tool. Compression crimp shall be applied on upstream and downstream side of EPDM seal bead.

D. Installers shall be credentialed by fitting manufacturer within the last two years. Submit credentials for review

E. Press fittings shall be Apollo "PowerPress Gas" or Viega LLC "MegaPressG". There shall be no mixing of fittings from different manufacturers.

2.3 Gas Pressure Regulators

A. Gas pressure regulators shall be self-operating spring loaded type. Valve body shall be cast iron, 125 psi construction with screwed or flanged connections. Spring and diaphragm casings shall be aluminum. Regulator shall have verpressure protection shall be ten times the inlet pressure (or higher as may be required by the gas company). Vents on exterior regulators shall be oriented or piped so discharge is directed downwards.

B. Regulators serving individual equipment shall be Sensus 143/243/121/122 or approved equal.

C. Refer to the drawings for capacity and inlet and outlet pressures of each regulator.

2.4 Shutoff valves shall be:

A. Non-lubricated plug valve. Durco, Nordstrom, Homestead, DeZurick, Newman-Milliken. 2 inches and smaller, Durco G432, 150 psi, carbon steel body, threaded ends, flat head.

B. Lubricated plug valve. Nordstrom, Homestead, DeZurik, Durco, Newman-Milliken. 2.50 inches and larger. Iron body, 200 psi. Nordstrom No. 143 with flanged ends.

C. Ball valve. Hammond, Nibco, Milwaukee, Watts, Apollo. 2 inches and smaller. Hammond 8901, 600 psi non-shock WOG, two-piece forged brass body, screwed ends, brass stem and ball with chrome plating, reinforced TFE seat and seal, handle.

D. Provide a handle with each valve.

2.5 Pipe hangers shall be provided as specified in 22 05 29 Hangers and Supports for Plumbing Piping. Unions, flanges, pipe sleeves and firestopping shall be provided as specified in 22 05 07 Piping Materials and Methods for Plumbing.

PART 3 - EXECUTION

3.1 Valves, unions and threaded joints are not permitted in inaccessible concealed locations. Valves shall not be located in ceiling air plenums and other air plenums or ducts.

3.2 A shutoff valve and a dirt and moisture leg with screwed end cap shall be provided on the pipe drop to each item of equipment.

3.3 Gas pressure regulators shall be installed in accordance with manufacturer's instructions. Provide valved gauge taps upstream and downstream of the regulator and a pressure gauge on the downstream side. Provide pilot regulator piping and miscellaneous valves, devices and piping to complete the installation.

3.4 Vent piping shall be extended individually from each regulator and gas venting device to outside the building.

3.5 Purging of fuel gas piping shall be conducted in accordance with the criteria and procedures outlined in the International Fuel Gas Code for the opening of existing piping systems and/or the placing of new or revised piping systems in operation.

END OF SECTION

22 11 16 INTERIOR DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 Piping, valves and associated devices and materials for non-potable, interior domestic cold water, hot water and hot water recirculating systems shall be provided as shown on the drawings and as specified.

1.2 Exterior below grade domestic water service shall be provided from the bus garage to the bus wash outbuilding. Service work shall include related piping and devices per drawings.

1.3 Refer to Section 22 05 07 - Piping Materials and Methods for Plumbing, Section 22 05 23 – General Duty Valves for Plumbing Piping, Section 22 05 29 Hangers and Supports for Plumbing Piping and other related sections for required provisions.

1.4 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Water piping and associated devices, materials and accessories shall be as described in Section 22 05 07 Piping Materials and Methods for Plumbing. Piping shall be:

A. All piping 4 inches inches and smaller unless specifically noted below - Type C1, Type C3, and Type C6.

B. Pipe nipples extending out of the wall to connect fixtures - brass with screwed ends. Exposed piping shall be chrome plated.

A. Below grade water service pipe shall be Type “K” soft copper tubing, ASTM B88. Joints shall be silver brazed – Type C3.

2.2 Valves for the various services shall be as listed below and as described in Section 22 05 23 General Duty Valves for Plumbing Piping.

A. Shutoff
   1. Ball — B1 / B2 , B4

B. Check

   1. Swing — C1, C2, C6

PART 3 - EXECUTION

3.1 Installation shall conform to provisions in Section 22 05 07 Piping Materials and Methods for Plumbing and Section 22 05 29 Hangers and Supports for Plumbing Piping.

3.2 Excavation, bedding, laying of pipe, backfill and surface restoration shall conform to Section 22 05 09. Pipe shall be laid at a depth affording 4.50 ft. cover from finished grade to the top of the pipe.

3.3 Service piping shall be tested, cleaned and disinfected in accordance with Section 22 05 01.

END OF SECTION

22 11 19 INTERIOR DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 Water system specialties shall be provided as shown on the drawings and as specified.

1.2 Refer to 22 05 07 Piping Materials and Methods for Plumbing, 22 05 23 General Duty Valves for Plumbing Piping, 22 05 19 Meters and Gauges for Plumbing Piping (for thermometers and pressure gauges) and 22 11 16 Interior Domestic Water Piping.

1.3 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable water for human consumption shall conform to the “Lead Free” requirements of NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Reduced Pressure Backflow Preventer Assembly

A. Reduced pressure backflow preventer assembly shall be designed for high-hazard cross-connections and shall consist of:

1. Two spring loaded check valves and an intermediate automatic pressure differential relief valve assembly with air inlet, relief outlet and unit mounted (factory supplied) discharge air gap fitting.
2. Shutoff valves, one upstream and one downstream, ball type (2 inches and smaller) or resilient seated O.S.&Y. gate type (2.5 inches and larger). Refer to 22 05 23 General Duty Valves for Plumbing Piping for valve specifications.
3. Ball type test cocks.
4. Strainer upstream of the assembly. Refer to strainers specified in this Section.
5. Check valve upstream of the backflow preventer assembly to prevent nuisance discharge due to fluctuation in service line pressure.

B. 2 inch and smaller units shall have bronze body and screwed ends. 2.50 inch and larger units shall have coated cast iron bodies and flanged ends.

C. All components of the assembly shall be constructed of corrosion resistant materials or waterways shall be coated with FDA approved epoxy or other equivalent corrosion protection. The assembly shall be listed and labeled per ASSE Standard 1013, conform to AWWA Standard C511, and shall be listed by the U.S. Public Health Service.

D. Backflow preventers shall be Watts Series LF919/LF909/957/994 or equal by Apollo, Beeco, Wilkins, Conbraco, AMES or FEBCO.

2.2 Thermal Expansion Tank

A. Thermal expansion tank for expansion compensation in the domestic hot water system shall be pressurized diaphragm type, NSF or FDA approved and specifically constructed for domestic hot water systems.

B. The tank shall be welded steel constructed for 150 psi. The tank shall be fitted with a butyl rubber diaphragm (to separate water from the pressurized air section of the tank), stainless steel tapping for system connection and a standard tire air charging valve. Diaphragm type tank shall have a rigid polypropylene interior liner in the water section. Tank exterior shall be prime coat or finish painted.

C. Tank shall be equal to Amtrol "Thermo-X-Trol" or Wessels "TXA-FF", or equal by Watts of configuration and acceptance volume as indicated on the drawings.

2.3 Strainers shall 125 lb. w.s.p. "Y" pattern cast iron or bronze construction with removable stainless steel strainer element, tapped outlet for blow-down and screwed or flanged ends. Inside and outside of cast iron bodied strainers shall be NSF and FDA approved epoxy coated, ASTM B62 and meet NSF 372. Strainer elements shall be 20 mesh for 2 inches and smaller, 0.0625 inch for 2.50 inches, 3 inches and 4 inches and 0.125 inch for larger sizes. In 2.50 inches and larger sizes, a 20 mesh liner shall also be included for insertion inside the standard screen. Refer to Part 3 for blow down valves.

2.4 Point-of-Use Thermostatic Mixing Valves

A. Point-of-use mixing valves shall be designed to thermostatically blend hot and cold water for sink and lavatory supply. Valve construction shall be solid brass or bronze, with corrosion-resistant internal actuation components, union ends, and integral check valve and removable strainer on each inlet. Temperature control knob (field adjustable from 80 to 120 degrees F) shall have an adjustable stop and vandal-resistant locking mechanism. Unit shall be ASSE 1070 listed.

B. Valves serving individual faucets shall control to a minimum flow of 0.5 GPM and have a maximum 5 PSI pressure drop at 2.0 GPM. Valves shall have 0.375 inch compression, or 0.5 inch union-threaded or union-sweat connections.

C. Valves serving multiple faucets shall control to a minimum flow of 0.5 GPM and have maximum 10 PSI pressure drop at 4.0 GPM. Valves shall have 0.5 inch union-threaded or union-sweat connections.

D. On valves serving multiple fixtures, provide a temperature test plug (Pete’s plug) on the outlet to assist in setting the discharge temperature. See Section 22 05 19.

E. Point-of-use mixing valves shall be Powers, “Hydrogard” Series LM495 or equal by Apollo, Acorn, Bradley, Cash Acme, Leonard, Wilkins Caleffi, or Watts.

2.5 Wall hydrants shall be bronze, quarter turn, non-freeze, automatic draining type, with stainless steel face and integral vacuum breaker and dual check valve, 0.75 inch hose thread outlet, loose key stop, stainless steel recessing box with hinged locking cover, internal wheel handle and outer brass casing of length required for the wall thickness with integral union elbow. Unit shall comply with ASSE 1052. Hydrants shall be Smith 5619 / 5519 or equal by Woodford, Wade, Mifab or Zurn.

2.6 Interior hose bibbs shall be all brass construction with removable tee handle; 0.75 inch hose thread outlet and integral vacuum breaker, ASSE 1019. Hose bibbs shall be Chicago Faucet No. 998 with rough chrome finish or equal by T & S.

PART 3 - EXECUTION

3.1 Backflow preventers shall be located and installed in accordance with the manufacturer's recommendations and the Water Departments requirements. Clearances and elevation shall afford easy access for testing and servicing. Extend full size drain piping from the air gap fitting to a floor drain. Devices shall be tested at the time of being put into service. Submit test data in O & M manuals.

3.2 Strainers 2 inches and larger shall be fitted with a ball type blow-down valve. Discharge piping shall be extended to a floor drain.

3.3 Thermostatic mixing valves shall be installed in accordance with the manufacturers recommendations and details on the drawings.

3.4 Wall hydrants shall be located approximately 24 inches above final grade. Verify length of casing vs. wall thickness and location of wall insulation to preclude a freezing condition for the hydrant.

3.5 Interior hose bibbs in mechanical rooms and other unfinished areas shall be mounted approximately 36 inches above the floor.

END OF SECTION

22 11 50 LIQUID FUEL SYSTEM

PART 1 - GENERAL

1.1 Liquid fuel system shall be provided as shown on the drawings and as specified herein for a complete operating and approved installation. The system shall be complete with fuel tanks, underground piping, piping to fueling dispensers, pumps, valves, fuel management and leak detection system, tank gauging system, for fuel dispensing facilities and accessory equipment and devices.

1.2 The system and its components shall conform to EPA, federal, state and local regulations and to NFPA 30 and 30A.

1.3 Refer to 22 05 07 Piping Materials and Methods, 22 05 09 Excavation Backfill and Surface Restoration, 22 05 13 Electrical Requirements for Plumbing Equipment and 22 05 53 Identification of Plumbing Piping and Equipment.

PART 2 - PRODUCTS

2.1 Underground Storage Tanks

A. Underground fuel tank shall be double wall containment type having fiberglass reinforced polyester inner and outer tanks, with reinforcing ribs and interstitial space. Tanks shall comply with UL 1316 and ASTM D4021. Tank shall be by Xerxes, Containment Solutions, or approved equal.

B. Tank(s) shall be constructed of materials, which are chemically inert to petroleum products and are capable of storing gasoline at ambient underground temperature and at temperatures not to exceed 150 degrees F.

C. Tank construction shall incorporate a safety factor of 5:1 for fiberglass tanks against general buckling when buried in the ground with 7 feet of overburden and the hole fully flooded and surface H-20 axle loading when installed in accordance with manufacturer's recommendations. Tank and interstitial space shall withstand a 5psi internal air pressure test with 5:1 safety factor.

D. Tanks shall have an annular space between the primary and secondary shell walls to allow for the free flow and containment of all leaked product from the primary tank or for hydrostatic monitoring. One 4 inch access fitting shall be provided to the annular space between the tanks to monitor leakage of the inner tank.

E. Each tank shall be covered by the manufacturer's standard 30 year warranty regarding external corrosion, internal corrosion, structural failure, and material defects.

2.2 Tank Accessories

A. Tank shall be equipped with manway and pipe openings as shown on the drawings and as required for the various pipe, monitoring and gauging connections, and an additional 4 inch spare connection. Manways shall be furnished with UL listed gaskets, bolts and covers. Provide integrally mounted FRP reservoir, 4 inch riser pipe and 4 inch annular space fitting for hydrostatic monitoring. A strike plate shall be provided on the bottom of the tank under each opening.

B. Turbine enclosures and collars shall be fitted over the tank manway providing a watertight installation. The enclosures shall be 48 inches dia. (fuel supply enclosures) and 42 inches dia. (transfer enclosures) FRP with FRP reducer, watertight push-on FRP lids and o-ring seals. The sump shall be fitted with watertight bulkhead fittings for each pipe and conduit penetration.

C. Tank fill assembly: shall be remote watertight and shall consist of a 15-gallon high density polyethylene spill container, grade cover and mounting ring, lid with lever and drain-back apparatus overfill prevention valve, fill window and riser seal. All materials shall be corrosion resistant.

D. Fill tube shall be fitted with mechanical overfill prevention mechanism/valve.

E. Double poppet foot valve with metal-to-metal seat, 8-mesh screen, and extension legs, shall be fitted on each suction pipe.

F. Anchor straps and concrete deadman shall be furnished with and suitable for the tank.

G. Tank accessories shall be by the tank manufacturer or by Franklin Fuel Systems, Universal, EmcoWheaton, OPW, or approved equal.

H. In areas of traffic, grade lids shall be designed for surface H-20 axle loading.

I. Transition sumps shall be adjustable, ribbed polyethylene sump with fiberglass top equal to OPW FlexWORKS PST-4630. Provide concrete slab and minimum 36 inches diameter manhole frame and cover above lid.

J. Provide Schedule 40 PVC, 0.20 inch slotted observation well(s) to meet EPA requirements Wells to be equal to Environmental Well Products UST.

2.3 Underground Piping

A. The piping shall be UL listed for the service intended. Use of fiberglass or flexible piping shall be limited to buried service only and at pressures not exceeding that marked on the pipe.

B. Underground piping shall be double wall (primary and secondary) piping except where single wall is specifically noted. Secondary piping shall completely contain the primary pipe from the tank sump to transition sump / transition sleeve. Secondary pipe shall allow for complete inspection of primary pipe connections, during primary pipe hydrostatic testing, before the secondary pipe is sealed

C. The secondary pipe shall be made from materials to have sufficient strength to withstand the maximum underground burial loads, be non-corrosive, di-electric, non-degradable, resistant to attack from microbial growth, and compatible with the products to be stored.

D. Double wall piping shall be UL 971 listed, PVDF flexible smooth bore primary pipe with flexible secondary PVDF pipe and integral stand-off ribs to create and interstitial space, complete with fittings and accessories. The system shall be designed and installed so that the primary pipe is continuous from the tank sump to the transition sump with all fittings visible and accessible from within containment sumps. The pipe shall be installed in a corrugated flexible conduit so that it is removable and replaceable without excavation. Piping shall be OPW FlexWORKS, or equal by Franklin Fuels, Advanced Polymer Technology, Inc. or Western Fiberglass.

E. Vent Pipe and Fittings Below Grade
   1. Vent piping shall be single wall fiberglass having bonded joints. Pipe and fittings shall be Dualoy 3000/L as manufactured by Ameron or approved equal.

F. Non-Buried Piping

   1. Piping inside the building and other non-buried piping shall be Schedule 40 black steel, ASTM A-53, Types E and F, with 150 lb. seamless steel malleable iron threaded fittings and joints.

a. Pipe thread lubricant shall be manufactured specifically for use with petroleum products. Product shall be by Permatex, Gasoila, Loctite, Rectorseal, or approved manufacturer. Use of Teflon tape is not permitted. Contractor shall follow manufacturer's requirements for cure times.

2. Above ground vent piping shall be of identical material as underground vent piping or schedule 40 galvanized steel with galvanized malleable iron or cast iron threaded fittings.
   a. Vent pipe shall terminate in a vent cap with internal wire screen. Vent cap shall permit a vacuum or positive pressure in the tank to be relieved. Cap shall be by OPW, Universal, EmcoWheaten, or approved equal and be gasoline rated.
   b. Vent pipe shall terminate in a listed flame arrestor.
3. Shutoff valves shall be
   a. 0.25 inch to 4 inches, Ball type with three - piece bronze body, threaded ends, chrome plated bronze ball, TFE seat, and conventional / full port, blow out proof stem, handle, UL Listed for flammable liquids. Provide valve by OPW, Morrison Brothers, NIBCO, Universal, or approved manufacturer.
4. Pipe hangers, sleeves, installation methods and related items shall conform to applicable portions of 22 05 29 – Piping Materials and Methods.

2.4 Flexible Connectors

A. Flexible connectors shall be:

1. Seamless PTFE liner, high strength, and corrosion resistant stainless steel wire braid reinforcement. Fittings shall be made of ductile iron with NPT threads. Couplings shall be electrically isolated from the braid to eliminate corrosion. Swivel adaptors shall be used for connection to equipment.
2. Flexible metal hose, corrugated type with braided wire sheath covering, close-pitch annular corrugations, rated for a working pressure of at least 125 psig, 8 inches minimum live length, flanged / threaded end connections, UL listed for flammable liquid service. Metal for hose and braided wire sheath shall be ASTM 300 – series stainless steel.

B. Where flexible connectors are direct buried, adequate isolation and secondary containment sleeves or boots shall be supplied.

C. Flexible connectors are to be installed where shown on the drawings and at:

1. Tank connections to vents or vapor lines
2. Tank connections to product lines within the containment sump
3. Underground at base of vent risers.
4. Underground at changes in direction in non-flexible supply/return piping
5. Flexible connectors are to be supplied by Crane Resistoflex, Teleflex, or approved equal.

2.5 Submersible Fuel Transfer Pump(s)

A. Pumps shall be UL 79 listed, centrifugal, submersible type located in the underground storage tank as indicated on the drawings. Pump shall include ASTM A48 Class 25 gray iron discharge head and manifold assembly, thermal over-current overload protection with automatic reset, check valve, pressure relief valve, air eliminator, fluorocarbon seals, venture type siphon primer, adjustable pump length and diaphragm leak detector feature. Pump shall be manufactured by FE Petro (Franklin Fueling Systems), Red Jacket Pumps or approved equal. Pumps shall fit standard 4 inch NPT tank opening.

B. The control panel shall be complete with the following electrical components as listed below and as required to provide the sequence of operations described under Paragraph 2.6, C and D. The control strategy shall be microprocessor based, shall be factory configured, stored on an EEPROM, and shall safeguard against re-configuration by unauthorized or unqualified personnel. The control panel system shall include an LCD display for pump set status, alarm

listing, and troubleshooting functions. Provide a tactile feedback, numeric keypad for data entry. Pumps shall be capable of manual operation in the event of controller failure. Panel shall include:

1. Microprocessor-based control with LCD display and alarm/event and operator action log.
2. Control circuit transformer.
3. Alarm bell with alarm silence/reset pushbutton.
4. HAND/OFF/AUTO selector switches.
5. PUMP RUNNING indicating lights.
6. FAIL/OVERLOAD indicating lights.
7. Combination type motor starters with overload protection.
8. Motor circuit breakers.
9. Provisions to operate both of the fuel transfer pumps.
10. Provisions to accept a remote NC emergency stop pushbutton input.
11. RS485 Modbus communication interface for communications with a remote PLC system.
12. Isolated relay contact outputs to interface with a remote PLC system for the following conditions and alarms:
    a. Pump 1 running.
    b. Pump 2 running.
    c. Pump 1 fail.
    d. Pump 2 fail.
    e. Common alarm.
13. Main power disconnect switch for each pump.
14. Elapse time recorder to measure running time of each pump.

2.6 Fuel Pump Control and Alarms

C. Sequence of Operations – Pumps Serving Fuel Dispensers

1. The fuel transfer pump shall be started by any fuel dispenser. The lead fuel transfer pump shall be energized when either fuel dispenser fuel selector switch is manually engaged.
2. Upon the next call for fuel, the lead pump shall be automatically alternated.
3. Upon detection of loss of flow or lead pump thermal overload, the control system shall automatically energize the backup pump and de-energize the lead pump.
4. The fuel transfer pump shall be stopped by either fuel dispenser.

D. Safety Shut Downs:

1. Activation of the leak detector switch in the day tank interstitial space (5 percent full) shall signal a visual and audible day tank leak alarm and shall output an alarm condition to the remote system.
2. Activation of any emergency stop button shall shut down all fuel transfer pump sets.

2.7 Fuel Gauging and Leak Detection System

A. The storage tank fuel gauging and leak detection system shall be automatic tank gauging which will monitor and be capable of generating the required inventory and fuel management reports and perform continuous leak detection.

B. The system shall be microprocessor-based, complete with enclosure, graphic alarm and level indicators, integral audible and visual alarms, fuel storage tank overfill and low liquid level alarms, printer and RS485 / Ethernet Modbus interface. The system shall be intrinsically safe for Class 1, Division 1, Group 1, hazardous locations. Front panel display shall include audible and visual alarms, user-friendly pushbutton controls, and printer.

C. System shall have the capability to continuously monitor up to twelve (12) in-tank level probes and twenty-four (24) secondary containment leak or point-level sensors, all field configurable. Leak and point-level sensor inputs shall support a means to detect sensor open-circuit and short-circuit wiring faults as a standard feature when used in conjunction with fault-reporting sensors.

D. The system shall have the following features / capabilities:

1. Leak sensor testing.
2. Gasoline delivery verification.
3. Overfill alarming.
4. Data logging and printing for:
   a. Last (2) inventories
   b. Last (14) deliveries with time/date.
   c. Last (14) daily consumptions.
   d. Last (14) weekly consumptions.
   e. Last (10) time/date stamped alarms.
5. Minimum (8) outputs, including (6) relay and (2) 4-20 mA.
6. 120VAC, 60 Hz power input.

E. The system shall be or equal by Veeder-Root “TLS-450 Plus”, Pneumercator, Preferred Utilities Model TG-EL-D4A, INCON, Franklin Fueling Systems, or OPW Fuel Management.

F. Overfill alarm panel shall be surface-mounted, NEMA 4 weather-proof cabinet with 4 inches 92 db weather-proof bell with automatic silencing, (2) 4.375 inch diameter 180 degree visible flashing lamps (one for each tank), bell silencing pushbutton and alarm test pushbutton.

G. Monitoring of the tank interstitial space shall be by hydrostatic level monitoring. Hydrostatic monitoring of the interstitial space between the primary and secondary tank shall be by UL approved compatible solutions within the tank annular space. Solution shall have a contrasting color. Dual float reservoir switch sensor shall be equal to Pneumercator #RSU800-2.using electric-optic sensor. Monitor of the manway-piping sumps shall be by with UL listed containment collar float switch sensors (equal to Pneumercator #LS600-LD). Sensors shall be compatible with the monitoring system and shall be supplied by Preferred Utilities, Pneumercator, Veeder-Root, INCON, Franklin Fueling Systems, or OPW Fuel Management.

2.8 Miscellaneous Specialties

A. Access covers for pump and probe manway, observation wells, float vent valve-extractor assemblies, tight-fill adapters and caps, spill containers and vapor vents are specified on the drawings by manufacturers name and number. Specialties having comparable features and of equal quality by other manufacturers will be acceptable.

B. Fittings, manways, fill and observation wells shall be provided with locking capability.

2.9 Dispensers

A. Dispenser system shall be packaged assembly by Bennet/Gilbraco/Tokheim/Gasboy, or approved alternate manufacturer.

B. Provide dispenser system with following accessories:

1. Pump rated for 22 gpm.
2. Display registering digital readout of volume of product delivered, cost of product delivered, and manual readout of total volume delivered

3. 12 foot hose, front orientation, conforming to UL 330, gasoline and oil resistant, statically grounded, and flexible in sub-zero temperatures. Provide a spring loaded cable return device, attached near mid-length of the hose.
    a. Provide hose with UL listed breakaway valve fitting with a pressure-balancing chamber to override line pressure
4. Replaceable high capacity product filter with nominal filtration efficiency of 25 microns with a flow rating equal to the rate of the dispensing unit.
5. Emergency Shutoff Fitting
    a. Listed, rigidly anchored shut off valve, incorporating a fusible link / thermally actuated device to close automatically in event of severe impact or fire exposure.
    b. Listed, vacuum actuated shut off valve with shear section, installed directly under the dispensing device, installed in the supply piping to the dispensing unit, at the base of the unit or at the inlet of an overhead dispensing device.
    c. Fitting should also be supplied with a centering ring or stabilizer bar to ensure proper shearing action for the fitting.
6. Nozzle
    a. Listed, automatically closing type hose nozzle on remote dispensing devices used to dispense Class I / Class II liquids with latch open mechanism. Nozzle shall be fitted for Stage II vapor recovery.
7. Dispenser Form/Sump
    a. Dispensers shall be mounted on concrete filled island forms or sumps manufactured by Pomeco/OPW, Riverside Steel, Formex, or approved equal.
8. Emergency Electrical Disconnects
    a. Provide multiple clearly identified, emergency shut off device.

PART 3 - EXECUTION

3.1 Installation

A. Tank installation shall be in strict accordance with the manufacturer's recommendations and standard practices and procedures relating to handling, pre-installation testing, setting, in-place testing, piping and backfilling and in accordance with API RP 1615 – Installation of Underground Petroleum Storage Tanks.

B. Tank backfill material shall be clean and dry, well-graded pea gravel (rounded particles) having a minimum diameter of 0.125 inch and a maximum diameter of 0.75 inch. Fill material must be dry and free of ice and snow. Do not use sand or other backfill material.

C. A 12 inch inch thick pea gravel bedding shall be placed on the concrete hold-down pad before setting the tanks. Backfill shall then be placed around the tank(s) in 12 inch layers. The layers shall be carefully hand-tamped until the backfill reaches the springline of the tank. Care shall be taken to avoid leaving voids under or around the tank(s). Do not strike the tanks with the tamping bar. The remainder of the backfill is not required to be hand-tamped.

D. Backfilling to the top of the tanks shall be accomplished as soon as possible after the tanks have been set in place. Tanks will be filled with product (at Owner's expense) as soon as possible after the aforementioned backfill is in place. Tanks must be adequately vented during the "fill" operation. Accessibility by the tanker truck must be ensured by the Contractor.

E. Piping shall have a slope toward the tank of not less than 0.125 inch per ft. Pea gravel shall be used for bedding and backfill as previously specified.

F. Provide unions in pipes 2 inches and smaller, adjacent to each valve, and at connections near each piece of equipment to facilitate equipment removal. Provide flanges on valves, apparatus, and equipment having 2.5 inches and larger connections.

G. Provide detectable underground warning tape above all underground pipe. Tape shall be for utility involved, with warning and identification imprinted continuously and repeatedly over entire tape length. Warning and identification shall read “CAUTION BURIED PIPING BELOW” or similar wording. Provide tape with printed side up at a depth of 12 inches below top surface of earth or top surface of sub grade under pavements.

H. Vent piping shall extend at least a minimum of two (2) feet higher than any adjacent building.

I. Installation of fiberglass pipe and fittings shall be in strict accordance with the pipe manufacturer’s recommendations and standards.

J. Thoroughly flush piping before final connections to end use equipment are made. Flush piping, including any branch piping, at a minimum velocity of 8 feet per second. Furnish temporary pump and hose with strainer having not less than 40-mesh screen at the end of piping system for flushing. Flush piping with same type of fuel intended for use in system until out flowing fuel is free of sediment and has no cloud or haze.

K. Provide wiring and conduit, control wiring and interlocking between the fuel gauging system, underground storage tank, remote monitoring, over fill alarm panel and fuel pumps.

L. A fuel system trained representative shall be provided for installation supervision, startup and testing services, and operation and maintenance personnel training services. The representative shall make a minimum of two visits, minimum 8-hours on-site, for each visit. The first visit shall be for assistance in the installation of the equipment. Subsequent visits shall be for checking the completed installation, startup and training. The representative shall test operate the system. The representative shall revisit the site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

M. After equipment is fully operational, and before the Owner will assume responsibility for the operation of equipment, the representative shall instruct the Owner’s operating personnel in the care, maintenance and proper operation of the equipment. One training session shall be required. The session shall consist of 4-hours devoted to maintenance training.

N. Manufacturer’s installation reports shall be included in the project O & M manuals and shall include field testing reports, description of installation deficiencies not resolved to the Owner’s satisfaction, description of problems or potential problems, names of the Owner’s personnel who attended the operations and maintenance training sessions, and a record copy of materials used for the training sessions including an outline summary of the course.

3.2 Testing

A. Tanks (primary and secondary on double wall tanks) shall withstand 5-psi air pressure test with 5 to 1 safety factor. Contractor shall individually test tanks for leakage prior to installation. Maximum test pressure is 5-psi.

B. Pipe Testing

1. For pre manufactured, flexible double wall piping, test primary piping at all joints. Piping shall be tested in accordance with API RP 1100 – Pressure Testing of Liquid Petroleum Pipelines
2. For field fabricated systems, primary piping must be tested before installation of the secondary piping. Piping shall be tested in accordance with API RP 1100 – Pressure Testing of Liquid Petroleum Pipelines.
3. For field fabricated systems, secondary piping must be tested upon completion of installation with a minimum 5-psi air-pressure/soap test to confirm the secondary

containment integrity. This testing shall be in compliance with the manufacturer's published installation instructions.

END OF SECTION

22 13 16 INTERIOR DRAINAGE AND VENT SYSTEMS

PART 1 - GENERAL

1.1 Interior drainage and vent systems including soil, waste and vent system, interceptors and storm drainage system shall be provided as shown on the drawings and as specified.

1.2 Refer to 22 05 09 Excavation Backfill and Surface Restoration, 22 05 07 Piping Materials and Methods for Plumbing, 22 05 29 Hangers and Supports for Plumbing Piping and other related sections for provisions affecting this Section.

1.3 All referenced standards shall be of the latest edition adopted by the jurisdiction unless specifically noted otherwise.

1.4 All cast iron drainage and vent pipe, fittings and joining materials shall be listed to the respective standard(s) stated below, and shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

PART 2 - PRODUCTS

2.1 Interior soil, waste and vent piping.

A. Pipe in grade below the floor slab shall be Schedule 40 PVC, ASTM D2665. Fittings shall be drainage type, ASTM D2665. Joints shall be solvent welded ASTM D 2564. Primer shall meet ASTM F656.

B. Pipe, fittings and joints above grade shall be:
1. Pipe shall be coated cast iron, centrifugally cast with hubless ends, ASTM A-888 and CISPI 301. Fittings shall be drainage type with hubless ends. Joints shall be made with no-hub couplings consisting of a neoprene gasket, ASTM C564, Series 300 stainless steel shield and stainless steel band, CISPI 310, NSF certified and marked.

2.2 Storm Drainage Piping

C. Pipe in grade below the floor slab shall be Schedule 40 PVC, ASTM D2665. Fittings shall be drainage type, ASTM D2665. Joints shall be solvent welded ASTM D2564. Primer shall meet ASTM F656.

D. Pipe, fittings and joints above grade shall be:
1. Pipe shall be coated cast iron, centrifugally cast with hubless ends, ASTM A-888 and CISPI 301. Fittings shall be drainage type with hubless ends. Joints shall be made with no-hub couplings consisting of a neoprene gasket, ASTM C564, Series 300 stainless steel shield and stainless steel band, CISPI 310, NSF certified and marked.

2.3 Interceptors

A. Garage Master Trap / Solids Interceptors

1. The interceptor shall be constructed of 5000 lb. reinforced concrete complete with vent and cleanout openings and cast-iron manhole frame and cover, as detailed on the drawings. A standard precast basin of equal volume and strength and similar arrangement will be acceptable at the Contractor's option.

PART 3 - EXECUTION

3.1 Cut pipe to required length and ream ends to remove burrs. Align horizontal piping to attain even pitch, minimum of 0.25 inch per ft. on sizes 2.50 inches and smaller, 0.125 inch per ft. on sizes 3 inches and larger unless specifically noted on drawings.

3.2 Trenching, bedding and backfill for piping in grade below floor slab shall be in accordance with 22 05 09 Excavation, Backfill and Surface Restoration.

3.3 Piping shall not be run above electrical switchgear or panelboards, nor above access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 110.26.

3.4 The use of sealers or sealants for couplings in No-Hub cast iron systems is not acceptable unless specifically recommended by the coupling manufacturer. No-Hub type couplings shall be installed in strict conformance with manufacturer's recommendations.

3.5 Piping in air plenums shall not exceed maximum flame spread of 25 and smoke development of 50 as established by NFPA 255 test methods.

3.6 Horizontal above grade cast iron piping, in sizes 5 inches and larger, shall be braced to prevent horizontal movement and joint separation at each branch opening and change of direction. Bracing methods shall be as recommended by pipe manufacturer's installation instructions and the Cast Iron Soil Pipe Institute (CISPI) Handbook.

3.7 Provide hangers on plastic and glass piping at closer spacing than that for metal piping, in accordance with manufacturers recommendations. Plastic piping systems shall be installed in strict conformance with manufacturer's latest installation instructions.

3.8 When transitioning, below floor, non-plenum rated waste or storm pipe to above floor, plenum rated material, extend to a maximum 1 ft. above finished floor. Transition to plenum rated piping and continue with plenum rated material in wall and above ceiling.

3.9 Vent piping shall extend thru the roof to at least 12 inches above the roofline. The pipe penetration shall be flashed and made watertight.

3.10 The Plumbing Contractor shall engage a Roofing Contractor on a subcontract basis for roofing and roof insulation work.

3.11 Provide cleanouts in drainage piping as indicated on the drawings and:

A. In horizontal piping at intervals no greater than 100 ft. for 4 inch and smaller pipe, 100 ft. for 5 inch and larger pipe.

B. In sanitary and storm piping leaving the building for cleanout and testing purposes.

3.12 Exterior interceptors shall be bedded properly and installed level. Installation shall be as detailed on the drawings and per the interceptor manufacturer's installation and testing requirements.

3.13 PVC drainage piping shall not be used for equipment that wastes water above 140 deg. (commercial dishwasher, pot and pan sink, sterilizer, glassware washer, etc.).

3.14 Drainage and vent piping exposed to view in the kitchen area shall be painted with an aluminum enamel paint.

3.15 Maintain a minimum 4 inches backfill depth between the top of the pipe and bottom of the floor slab for all piping installed in grade below the floor. Installation, bedding and backfill for plastic pipe shall conform to ASTM D2321.

END OF SECTION

22 13 19 DRAINAGE SYSTEMS SPECIALTIES

PART 1 - GENERAL

1.1 Drainage systems specialties shall be as shown on the drawings and as specified.

PART 2 - PRODUCTS

2.1 Floor drains, trench drains and roof drains shall be as shown and scheduled on the drawings. Drains shall be equal to listed catalog numbers, type, size, materials and features. Drains shall be manufactured by J.R. Smith, Wade, Josam, Watts, Mifab or Zurn.

A. Floor drain traps shall be same material as the connecting piping.

2.2 Carriers for Wall Hung Fixtures

A. Closet chair carriers, ASME A112.6, shall be adjustable/fixed type, cast iron and steel construction, with neoprene gasket, floor plate, anchor foot assembly and rear anchor tie down. Wax gaskets are not acceptable. The nipple shall be adjustable without cutting or defacing the wall and yet maintain a tight joint. Closet chair carriers shall be capable of supporting a 500 lb. load.

B. Closet chair carriers shall be so selected and installed that the stud plate is tight against the back of the wall to afford a rigid mounting. Closet chair carrier configurations and auxiliary inlets shall be provided to comply with the piping configurations shown on the drawings. Plastic or metal positioning frames shall be furnished with closet chair carriers to separate the bolts from the wall construction.

C. Lavatory chair carriers, ASME A112.6, shall be concealed arm/hanger plate type, steel construction, welded footplates, adjustable positive mechanical locking device, designed for thin wall construction. Lavatory chair carriers shall be capable of supporting the lavatory with a 250 lb. vertical load applied to the front of the fixture.

D. Electric water cooler and drinking fountain chair carriers, ASME A112.6, shall be hanger plate or dual hanger plate type, steel construction, welded footplates, designed for thin wall construction. Electric water cooler chair carriers shall be capable of supporting the cooler with a 250 lb. vertical load applied to the front of the fixture.

E. Plumbing fixture carriers shall be provided for all wall hung fixtures, unless specifically noted otherwise, and shall be of the same manufacturer as floor and roof drains.

2.3 Cleanouts

A. Cleanouts shall be of the same manufacturer as floor and roof drains and equal to the listed catalog numbers in type, materials and features.

B. Cleanouts located in floors shall be J.R. Smith Series 4020 consisting of two-piece adjustable housing, ABS, cast iron or bronze NPT gasketed plug and round non-slip nickel-bronze cover with securing screw. Additional features such as clamping device for waterproof membrane, synthetic covering top, heavy duty top, carpet flange or carpet marker shall be provided as appropriate for the installation.

C. Cleanouts located in walls and partitions shall be J.R. Smith Series 4472 consisting of cast bronze plug and round stainless steel access cover secured by vandal-proof center screw. Wall cleanouts that cannot be made accessible in this manner shall be provided with an access panel as described in 22 05 04 Basic Plumbing Materials and Methods.

D. Exterior cleanouts in areas not subject to vehicular traffic shall be J.R. Smith Series 4220. Cleanouts shall consist of a cast iron two-piece adjustable housing, ABS, cast iron or bronze NPT gasketed plug and round non-slip cast iron top with securing screw. In area with decorative paving, tops shall be nickel bronze or bronze.

E. Exterior cleanouts in areas subject to vehicular traffic shall be J.R. Smith Series 4250. Cleanouts shall consist of ABS or cast iron gasketed plug, heavy duty double flanged housing and round non-slip cast iron cover with securing screws.

F. Refer to Part 3 for installation and concrete anchorage of exterior cleanout covers at grade.

PART 3 - EXECUTION

3.1 Floor drains shall be set with rim below finish floor level to permit continuous floor pitch to drain, unless otherwise noted or directed. Verify exact location and desired rim elevations before installation.

3.2 Roof drains shall be set as low as practicable in the roof construction to enhance the probability of complete drainage of the roof area served. Drains shall be compatible with the related roof construction. Installation shall be in accordance with architectural details when such details are provided.

3.3 Roof drains shall be installed with bearing pans extending 8 inches out from the clamping ring of the drain. The pan shall be placed on the roof deck below the insulation. Secure the clamping ring and drain top after the roofing membrane has been installed.

3.4 All carriers shall be equipped with feet properly adjusted to rest firmly on the floor. Carrier feet shall be block base type and shall be bolted securely to the floor slab using all bolt holes provided.

3.5 Cleanouts shall be same size as pipe thru 4 inch size. Maximum size of cleanouts shall be 4 inches diameter unless larger units are required for testing or special access purposes. Provide cleanouts where indicated on the drawings and at other locations where deemed advisable. Location of cleanouts as stipulated by applicable code shall be considered as the minimum requirement.

3.6 Exterior cleanout covers, when not installed in concrete or other poured hardscape surfaces, shall be set flush with grade and secured with 1 cu. ft. of concrete formed square, with top surface finished.

END OF SECTION

22 33 00 DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 Domestic water heating system complete, ready for operation including water heaters, thermal expansion absorber and all accessories shall be provided as shown on the drawings and as specified.

1.2 Each storage type heater shall be supplied with a T & P relief valve.

1.3 Refer to 22 05 12 Electrical Requirements for Plumbing Equipment, 22 05 19 Meters and Gauges for Plumbing Piping, 22 05 30 Bases and Supports for Plumbing Equipment, and 22 05 53 Identification of Plumbing Piping and Equipment and other sections for work related to this section.

1.4 Refer to Section 22 11 19 Interior Domestic Water Piping Specialties for recirculating pumps.

1.5 All piping, fittings, valves, solders, fluxes, seals, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

1.6 PRODUCTS

2.1 Electric Water Heater – Storage Type

A. Heater shall be listed by Underwriters’ Laboratories (UL 1453), and shall meet or exceed the standby loss requirements of the U.S. Department of energy and current edition of ASHRAE/IESNA 90.1. Heater shall have 150 psi working pressure and be equipped with extruded high density anode rod. All internal surfaces of the heater exposed to water shall be glass-lined that has been fused to steel by firing at a high temperature range. Electric heating elements shall be medium watt density with zinc plated copper sheath. Unit shall be completely prewired with controls, high limit and adjustable range operating thermostats, requiring only the connections of a power source at one location. Each element shall be controlled by an individually mounted thermostat and high temperature cutoff switch. The outer jacket shall be of baked enamel finish and shall be provided with full size control compartment for performance of service and maintenance through hinged front panels. The outer jacket shall enclose the tank over non-CFC foam insulation. Electrical junction box with heavy duty terminal block shall be provided. Heater tank shall have a 3-year limited warranty as outlined in the written warranty. Fully illustrated instruction manual shall be included.

B. Water heaters shall be manufactured by A.O. Smith, Bradford White, Lochinvar, PVI, RheemRuud, Bock, or State.

2.2 Thermal Expansion Absorber

A. Refer to Section 22 11 19 Interior Domestic Water Piping Specialties.

PART 2 - EXECUTION

3.1 Installation

A. Provide a drain pan with drain under all floor mounted storage heaters.

B. Provide a welded steel frame or wall support for wall or ceiling supported storage heaters.

C. Maintain manufacturer's recommended clearances around and over water heaters.

D. Provide unobstructed drain from T & P relief valve to the floor/drain pan as shown on drawings.

END OF SECTION

22 42 00 PLUMBING FIXTURES

PART 1 - GENERAL

1.1 Plumbing fixtures installed in place complete with supports, supply and waste trim shall be provided as shown on the drawings and as specified.

1.2 Refer to Division 7 for submittal, qualification, storage, handling warranty and installation requirements for joint sealants. Shop drawings shall be submitted to the Architect / Engineer for review and approval.

1.3 All plumbing fixtures, equipment and trim shall meet the dimensional and performance requirements of the ANSI, ARI, ASME, ASSE and/or CSA standards listed in the current jurisdictional plumbing code.

1.4 All piping, fittings, valves, solders, fluxes, seals, fixtures, appurtenances and other equipment in which wetted parts are in contact with water, installed in public drinking water systems and plumbing systems providing potable and/or drinking water for human consumption shall conform to the “Lead Free” requirements of NSF 61, Annex G and NSF/ANSI 372.

PART 2 - PRODUCTS

2.1 Fixtures and Trim:

A. Refer to schedule on the drawings for fixture specifications, including supply and waste trim and carriers where required. The schedule lists catalog numbers of various manufacturers. These catalog numbers are for the purpose of comparison to establish the construction material, quality and features of the fixtures and their components. Fixtures of equal quality by manufacturers listed in each category will be acceptable.

B. Fixture supply trim shall be of non-ferrous construction and supplies to each fixture shall be individually valved. Valves, supplies and escutcheons shall be furnished with the fixture supply trim.

C. Where exposed to view, all waste trim and supply trim shall be brass chrome plated furnished with wall escutcheons.

D. Screwed nipples serving fixtures from copper tube supply system shall be solid brass to avoid electrolytic corrosion. Exposed nipples shall be chrome plated.

E. Fixtures shall be white unless otherwise noted.

F. Water cooler color selection from optional colors by Architect.

2.2 Joint Sealants

A. Joint sealants shall be by Pecora, Sonneborn, Tremco, or equal by Division 7 listed manufacturers.

B. One part, mildew resistant silicone, ASTM C-920, Type S, Grade NS, Class 25 with fungicide, white, equal to Pecora 898.

PART 3 - EXECUTION

3.1 Installation

A. Space fixtures and rough-in carefully. Fixtures shall be carefully assembled and connected to the required plumbing outlets so the equipment will be ready for use when work is completed. Height shall be within 0.50 inch of specified nominal.

B. Secure supply and waste piping in chases and walls to preclude loose and ill-fitting pipes thru wall. Drop ear ell fittings shall be utilized at all supply nipples and shower arms.

C. After installation of the fixtures is completed, all connecting pipes shall be flushed out through the fixtures to eliminate scale, and all valves shall be properly adjusted and fixtures left complete and ready for use. All fixtures shall be cleaned immediately prior to acceptance by the Owner.

D. Seal joints around each fixture at wall, floor and any adjacent construction.

END OF SECTION

23 05 01 BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions, and Supplementary Conditions, including Divisions 00 and 01, apply to work specified in this Division.

B. The scope of the Division 23 work includes furnishing, installing, testing and warranty of all work and complete HVAC systems as shown on the M series drawings, and as specified in Division 23 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Construction Manager at Risk, assignments of work by division are not intended to restrict the Construction Manager at Risk in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the Division 23 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

1.3 Inspection of Site

A. Inspect the project site. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect & Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.4 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect & Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect & Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having ductwork, pipe and fittings fabricated and delivered in advance of making actual

measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install ductwork, piping and equipment.

D. The Architect & Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where considered desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork or piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by the National Electric Code (NEC).

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's & Construction Manager's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary drains and minor valves, traps, dampers and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect & Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect & Construction Manager.

1.5 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.6 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction and the coordination process. Upon completion of the work, and within 90 days of system acceptance, these drawings shall be turned over to the Architect & Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.7 Operating and Maintenance Manuals

A. Assemble electronic and physical copies each of operating and maintenance manuals for the HVAC work.

B. All "approved" shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of

checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate.

C. Final air balance reports and as-built automatic temperature controls drawings and specifications shall also be included.

D. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

1.8 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 23 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected their work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken to the satisfaction of the Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.9 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect & Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Use of equipment for temporary heating or cooling is not the start of the warranty period.

1. Certain items of equipment are specified to have multi-year parts and labor warranties. Refer to individual equipment specifications.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.

C. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling, belt tightening and cleaning strainers after these have been done for final close-out.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

2.2 Listing and Labeling

A. All equipment and appliances shall be listed and labeled in accordance with the Mechanical Code. Testing shall be performed by an Approved Agency, with the seal or mark of the Agency affixed to each piece of equipment or appliance.

2.3 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.4 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will only be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

D. If extensive changes in pipe, duct or equipment layout, electrical or control wiring, or equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract, including other effected trades.

2.5 Shop Drawings

A. One set of electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following HVAC equipment and materials shall be submitted:

1. Vibration isolators.
2. Ductwork insulation.
3. Heating and Ventilation units.
4. Unit heaters.
5. Fans.
6. Air outlets and inlets.
7. Louvers.
8. Split system heat pumps.
9. Gravity roof ventilators.
10. Piping,
11. Piping insulation.
12. Flue vent piping.
13. Automatic Temperature Controls.

PART 3 - EXECUTION

3.1 Pipe Testing

A. All piping provided in this work shall be pressure tested, as specified below, including all connected coils and equipment.

B. Pipe testing for HVAC piping shall be:

1. Condensate drainage piping, same as for plumbing drainage piping.

2. Refrigerant piping - refer to appropriate Refrigeration Sections.

C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.

D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date, system, pressure, duration and results of tests. Copies of test reports shall be included in the O&M manuals.

E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.

3.2 Operation and Adjustment of Equipment

A. As each piping system and air distribution system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.

B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.

3.3 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect & Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O&M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

3.4 Spare Filters

A. Furnish one complete initial set of filters and one complete set of spare filters for each filter bank in the project. This is in addition to filters used for temporary heating.

END OF SECTION

23 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format for a cost as indicated in the Agreement and Waiver Form. **Providing the documents in a .DWG version that differs from the product version that the .DWG files were initially created in will incur additional charges per sheet, as indicated in the Agreement and Waiver Form.** Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's, Engineer's, and any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies

in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

23 05 02A
ELECTRONIC FILES HEAPY RELEASE FORM TO CONTRACTORS

Project: GDRTA Garage

Owner: Montgomery County

Heapy Engineering Project Number: 2023-07202

Heapy Engineering Project Manager: Don Timmer

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider’s Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

    b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

    d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Name of authorized Recipient Representative: _____

    Title of authorized Recipient Representative: _____

    E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Cost Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ Heapy FTP ☐ User's FTP site ☐ Project FTP site (when available)

C. Delivery of Electronic Files Cost Summary:

Available Electronic .DWG file format:
☐ 20XX DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG
Note that an additional charge per sheet will be incurred.

Cost of Preparation of Division 23 Electronic .DWG Files:

First Drawing: $50.00 $50.00

Additional Drawings $15.00 each _____ x $15.00 = $ _____

Conversion to .DWG version different from available .DWG:
$5.00 additional/sheet _____ x $ 5.00 = $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____
All files will be bound together.
Available electronic Revit file format:
☐ 20XX .RVT

Cost of Preparation of Division 23 Electronic Revit Model Files:

Revit Project Model without Views $500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.) $ _____

23 05 04 BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Temporary Heating and Cooling

A. The temporary heating and cooling for construction is provided by the Contractor. Refer to Division 01 - General Requirements.

B. Fuel and electric costs attendant to temporary heating and cooling are not included in Division 23.

C. The use of the permanent HVAC systems for temporary heating and cooling during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period. Provide and maintain temporary air filters (same as specified permanent filters) to protect coils and ducts. Replace temporary filters with the clean specified filters when the systems are turned over to the Owner. Air filters specified for the systems and units, including specified spare filters, are not to be used for temporary service.

D. Cover all return duct openings with temporary MERV 8 filter media. Stop fans during heavy dust generating operations. Before turning the system over to the Owner, clean duct interiors and interior surfaces and components of the air handling equipment.

E. Warranty periods on equipment, materials and system shall commence upon Owner acceptance of the building or systems. Temporary heating or cooling use shall not jeopardize or alter the warranty requirements.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed valves, traps, devices and equipment requiring service or adjustment.

B. Access panels shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock. Locks in “secured” areas of the building shall have tamperproof screws. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.

C. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all

respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

3.2 Protection

A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect and Construction Manager.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements and Special Conditions for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where ducts are to pass thru new walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Trades to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, cut holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect or Construction Manager. Any damage caused to the building shall be repaired or rectified.

C. When cutting or core-drilling floor verify location of existing electrical, plumbing or steel reinforcement. Use X-ray method to verify existence of obstructions. Either re-route existing system brace floor or alter location of new work to maintain existing system.

D. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

E. All materials, methods and procedures used in patching and refinishing shall be in accordance with applicable provisions of specifications governing the various trades, and shall be completed by skilled workmen normally engaged in these trades. The final appearance and integrity of the patched and refinished areas must meet the approval of the Architect. Wall, floor and ceiling refinishing must extend to logical termination lines (entire ceiling of the room repainted, for instance), if an acceptable appearance cannot be attained by finishing a partial area.

F. Provide steel angle or channel lintels to span openings which are cut in existing jointed masonry walls where the opening span exceeds 16 inches. Provide framing around roof openings for required support of the roof deck.

3.4 Access Panels

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall. Caution the Installing Contractor to provide appropriate framing with drywall beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

END OF SECTION

23 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of piping and non-fire dampered ducts thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements and HVAC drawings for pipe and duct layouts.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the code and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required by the Building Code.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Firestopping shall not be installed at fire dampers that would impair the needed free expansion of damper, sleeve and retaining angles in a fire condition. Refer to the installation instructions of the fire damper manufacturer.

3.4 Refer to 23 05 07 Piping Materials and Methods for pipe sleeve requirements and treatment of penetrations not requiring firestopping. Refer to 23 31 13 HVAC Ductwork for duct sleeve requirements where firestopping is required.

END OF SECTION

23 05 07 PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Piping materials and methods shall be as specified herein and as shown on the drawings.

1.2 Included in this section are:

A. Pipe, fittings and joining methods.

B. Unions.

C. Dielectric connectors.

D. Pipe sleeves, and escutcheons.

E. Installation methods of piping.

1.3 Refer to other Sections in Division 23 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.4 Refer to Section 23 05 05 Firestopping for firestopping requirements.

1.5 Pipe sleeves and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and to allow for expansion, contraction and normal movement of the pipe.

1.6 Sleeves are not required:

A. For insulated piping passing thru stud and gypsum board or plaster walls and partitions which are not fire rated.

1.7 Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed to retard the passage of smoke.

PART 2 - PRODUCTS

2.1 Copper tubing, conforming to ASTM B88, Standard Specification for Seamless Copper Water Tube and Fittings and Joints, shall be:

A. Type C4
Pipe - Type “L” seamless hard drawn copper tubing.
Fittings - wrought or cast DWV, solder ends, ASTM B16.
Joints - soldered with lead-free tin alloy, 95-5 tin-antimony or silver-bearing tin equal to Harris "Stay-Brite", "Stay-Brite 8" or "Bridgit".

2.2 Unions shall be:

A. Unions on copper tubing, all bronze construction 150 lb., solder ends.

2.3 Dielectric connectors are required at each connection between ferrous and non-ferrous piping. Insulating materials shall be suitable for system fluid, pressure and temperature. Connectors shall be one or more of the following:

A. Brass adaptor.

2.4 Pipe sleeves shall be:

A. Schedule 40 black steel pipe or 18 gauge galvanized steel in poured concrete floors, walls and roof decks.

B. 26 gauge galvanized sheet steel or Schedule 40 black steel pipe in other than poured concrete.

2.5 Piping and conduits extending thru the roof may be fitted with a manufactured pipe curb weatherproofing assembly equal to Pate pca, lpca and mpca as an alternative to riser sleeves with clamping rings specified above.

2.6 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

PART 3 - EXECUTION

3.1 Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.

3.2 Piping shall be pitched for drainage. The low points shall be fitted with a 0.75 inches drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1.25 inches and smaller where a drain valve is not shown, a drain plug is acceptable. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.

3.3 Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.

3.4 Piping shall be supported as specified in Section 23 05 29 Hangers and Supports for HVAC Piping. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.

3.5 Close open ends of piping during installation to keep interior of the pipe clean.

3.6 Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with the National Electric Code (NEC).

3.7 Unions shall be installed at pipe connections to fixtures and equipment and as required for erection purposes.

3.8 Pipe sleeves shall be placed, and structural footing relieving arch requirements shall be coordinated, in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the project Structural Engineer.

3.9 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water, refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.10 Refer to 23 05 05 Firestopping. Pipe sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.11 In lieu of firestopping and where permitted by the local code, uninsulated metallic pipes requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls or partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar).

3.12 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.

3.13 Dielectric connectors shall be provided at all locations described herein, at each connection between ferrous and non-ferrous piping, and as shown on the drawings.

3.14 Cooling condensate drain piping shall be installed per details and equipment manufacturer’s instructions. Horizontal runs shall be pitched to drain, constructed with DWV fittings, and provided with a clean-out every 50 LF of piping unless shown more frequently on the plans

END OF SECTION

23 05 13 ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Motors, starters, disconnects, devices, fuses, wiring and other electrical work included in Division 23 shall be factory installed or furnished and field installed as specified in the various specification sections and as shown on the drawings. Refer to the project documents for requirements related to each trade. Coordinate all aspects of electrical components and wiring to complete the systems.

1.2 Equipment control panels containing power control components shall be marked with the minimum SCCR rating. The rating shall not be less than the available fault current. Refer to the electrical drawings for the calculated available fault at the distribution panel, MCC or panelboard serving the equipment. Include confirmation of being protected from the fault current in the equipment shop drawing submittal.

1.3 Note: Equipment with Electronically Commutated Motors (ECM's) are sometimes factory programmed to limit current draw to the motor, to limit the available brake horsepower to better match specified performance and reduce required power circuiting. This reduced brake horsepower is likely below the motor's nameplate rating. The electrical design documents may be sized based on the ECM's nameplate motor horsepower. The equipment supplier shall notify the Division 23 and 26 contractors and the Engineer if the maximum overcurrent protection on the design documents differs from their selected equipment's nameplate data. Any required revisions to the electrical circuiting, including maximum over-current protection devices, shall be documented on the shop drawing submittal. The required revisions must be forwarded to the Division 26 contractor with enough time to adjust the over-current protection and the electric circuit installation. However, any additional cost associated with increased electrical feeder/breaker sizes or lack of coordination listed above shall be the Division 23 contractor's responsibility.

1.4 Refer to the Electrical drawings and verify adequacy of feeder size, sets of conductors and size, disconnecting means and other electrical requirements. Compare these to the requirements of the equipment to be furnished and report deficiencies and / or discrepancies to the Engineer in the bid period for resolution by addendum. Bear all costs for electrical changes where such issues are not properly resolved.

1.5 Equipment and devices shall comply with applicable standards of NEMA and shall be UL listed. All work shall comply with the National Electrical Code.

1.6 Electrical equipment, devices, fuses, wire, conduit and methods shall comply with applicable provisions of Division 26 - Electrical.

PART 2 - PRODUCTS

2.1 Motors

A. General purpose motors shall be induction type 1750 rpm NEMA Design "B" with copper windings, Class B or F insulation, and motor enclosure to suit the application. Service factor shall be 1.15 minimum.

B. Two-speed motors shall be two-winding type with six leads unless otherwise specified.

C. Motors for other than general duty application shall be furnished to suit the application and operating environment.

D. Premium efficiency motors shall be equal to Century "E + 3", General Electric "Energy Saver Premium Efficiency", Baldor "Super E Premium Efficient" or Reliance "Premium Energy

Efficient" series. Motor efficiencies shall be tested and conform to NEMA Standard Publication MG-1 and IEEE 112 Test Method B.

E. Motors used with Adjustable Frequency Motor Controllers (Variable Frequency Drives) shall be rated for inverter service in accordance with NEMA Standard Publication MG-1, Part 31 and designed with Class F or H insulation, but with a Class B temperature rise. Motors connected to VFD's shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer.

F. Motor sizes shown on the drawings are to be considered minimum. Motors furnished shall be sized so as to not operate in the service factor range. Motors for direct driven pumps and fans shall be selected so as to not operate in the service factor range at any point on the curve.

G. Compare the electrical power requirements of the intended equipment with power feeders to the equipment shown on the Electrical drawings. Verify adequacy and compatibility of voltage, phase, wiring capacity, number and size of conductors (versus equipment connection points), maximum over-current protection, fusing and other information to that required for the equipment. If the selected equipment requires revision of the electrical, include any added cost to do so.

2.2 Magnetic starters shall comply with provisions of Division 26 - Electrical specifications and shall be NEMA construction (IEC rated not acceptable) with thermal overload element on each phase, 115 volt control voltage and hand-off-automatic switch, where appropriate. An integral control transformer shall be incorporated in the starter for each motor of 200 volt and greater. A single control transformer is acceptable for multiple motor packaged equipment, however, when such is the manufacturer's standard. Duplex type units (pumps, compressors, etc.) are not included in this exception. A control transformer shall be provided in each starter to ensure standby operating capability.

2.3 Wire and conduit shall comply with applicable provisions of Division 26 - Electrical specifications. Control wiring lighter than No. 12 AWG is acceptable where lesser ampacity will permit. All power and control wiring shall be overcurrent protected per the National Electric Code.

PART 3 - EXECUTION

3.1 Motor connections of factory assembled equipment shall be made with flexible conduit except for plug-in electric cord connections.

3.2 All power wiring shall be run in conduit. Control wiring shall be run in conduit except where open wiring is specified in the various sections.

3.3 Fuses shall be furnished and installed in fuse clips of equipment and switches.

END OF SECTION

23 05 29 HANGERS AND SUPPORTS FOR HVAC PIPING

PART 1 - GENERAL

1.1 All piping shall be supported from the building structure.

1.2 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC.

1.3 All products and assemblies installed with-in the building shall not exceed a maximum flame spread of 25 and a smoke development of 50 as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

PART 2 - PRODUCTS

2.1 Manufacturers listed below are basis of design. Other applicable manufacturers are B-line, Erico, Fee, Mason and PHD.

2.2 Hangers and supports for horizontal piping shall be equal to:

A. General service - clevis type Anvil Fig. 260.

B. Uninsulated copper tubing - copper plated clevis type - Anvil Fig. CT-65 (or plastic coated clevis).

2.3 Hanger rods shall be solid steel, threaded end or all thread rod, of diameter listed below. A hanger attachment device (beam clamps, concrete inserts, etc.) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis, trapeze and swivel ring type hanger.

Pipe Sizes	Min. Rod Dia.
2” and smaller	0.375"

2.4 Where the length of the hanger rod between the top of the hanger and the attachment device is 3 inches or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel.

2.5 Hanger rod attachment devices for attachment to the structure shall be:

A. Beam clamps for steel construction equal to Anvil Fig. 92, 93, 94 or 14.

B. Channel support systems equal to Unistrut or Hilti.

C. Multi-purpose rod hanger for structural purlins equal to Erico Caddy Model #PH, Fig. #2 for pipe sizes up to 3 inches.

2.6 Refer to Part 3 for steel spring and neoprene isolators in hanger rods, required for piping connecting to vibration isolated and/or motor driven equipment.

2.7 Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, provide insulation inserts and shields as specified in 23 07 19 HVAC Pipe Insulation.

2.8 Insulation shields shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

PART 3 - EXECUTION

3.1 Spacing of hangers and supports shall be as follows, unless otherwise shown on drawings:

A. Copper tubing (vertical) - at the base, at each floor level, and 10 ft. maximum spacing.

B. Copper tubing (horizontal) - 6 ft. spacing for tubing 1.25 inches size and smaller, 8 ft. spacing for 1.50 inches thru 2.5 inches sizes.

3.2 Attachment of pipe hangers to the structure shall be with:

A. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment.

B. Unistrut type channel support system may be utilized where a number of pipes are run parallel. Channel shall be pre-set or attached to the structure with inserts or clamps.

C. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

D. Attachment to manufactured trusses, joists, purlins, and other engineered structural members and supports shall be done in strict accordance with the structural engineer's or manufacturer's recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural engineer or manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances. In the case of existing trusses, the structural engineer must review and approve pipe hanger attachment methods.

3.3 Pipe hangers shall be adjusted to proper elevation, hanger rods set in a vertical position and locking nuts secured before pipe insulation is installed.

3.4 Hanger and support assemblies which are not factory plated (galvanized or copper) and will remain exposed on completion of the project shall be painted before installation.

3.5 Do not bend hanger rod to set in vertical position. Use manufactured hanger rod attachments that swivel to allow the hanger rods to hang vertically, or provide supplemental steel attached to the building structure and standard hanger rod attachments to allow the hanger rods to hang vertically. Refer to the following Manufacturers Standardization Society (MSS) Standard practices on pipe hangers and supports:

A. MSS SP-58 on Materials, Design and Manufacturer

B. MSS SP-69 on Selection and Application

C. MSS SP-89 on Fabrication and Installation Practices

END OF SECTION

23 05 30 BASES AND SUPPORTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Equipment shall be supported on concrete bases, roof curbs and structural steel supports as shown on drawings or as specified. All bases, curbs and supports shall be included except as otherwise noted.

1.2 Wind Load Analysis

A. HVAC equipment, ductwork, piping, conduits, etc. exposed to wind shall have positive attachment to the building structure or ground to comply with wind load requirements of the building and mechanical codes.

B. Wind speed design shall be 120 MPH. Refer to structural drawings for additional design requirements.

C. The contractor shall retain a specialty consultant to perform wind load calculations in accordance with the code and additional requirements specified in this Section. A professional engineer experienced in wind load attachment design and installation and licensed in the state where the project is located shall be responsible for calculations, attachment selections and installation details.

D. The Wind Load Analysis consisting of attachment design, calculations, attachment selection, installation details including anchoring methods, fastener specifications, embedment and/or welded length, etc..shall be submitted for review and record. This submittal shall be signed and sealed by a professional engineer, as stated above. This submittal will become part of the project design calculations, included in the project records, and when required, will be submitted to the authority having jurisdiction.

E. The wind load attachment design shall clearly indicate the attachment points to the building structure and design forces in all horizontal and vertical axes at the attachment points. The wind load attachment engineer shall coordinate all attachments with the projects structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed.

F. The wind load attachment design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the manufacturers. The equipment manufacturer shall verify that the attachment points on the equipment can accept the combination of wind load, weight, and other loads imposed.

G. At the project Engineer of Record’s discretion, equipment submittals may not be approved until the Wind Load Analysis has been submitted. It is the contractor’s responsibility to schedule and coordinate the process in a timely fashion, including follow-up Wind Analysis submittals for equipment approved pending a Wind Analysis submittal.

PART 2 - PRODUCTS

2.1 Support for equipment shall be by one or more of the following methods:

A. Concrete bases and pads with anchor bolts cast in place. Provide a 4” thick concrete pad that is minimum 4” wider than the equipment in each direction, formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Large concrete pads on grade shall be constructed with reinforcing steel or reinforcing roadway mesh. Set anchor bolts as required for the equipment.

B. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.

C. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.

2.2 Provide exact dimensions, locations and other detail for the specific equipment provided that requires bases or supports. Set anchor bolts as required for the equipment.

2.3 Equipment roof supports shall be heavy gauge galvanized steel support curbs with base plate, continuous welded corner seams, integral raised cant to match roof insulation, internal insulation, wood nailer and counterflashing. Unless otherwise noted, top of curbs shall extend 12” above the finished roof surface, 18” above for intake applications. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

2.4 Rooftop heating cooling units shall be roof curb mounted. Curbs shall be furnished with the equipment and meet the following requirements:

A. The roof curb shall be 18” minimum height. Gasketing shall be furnished for field installation to ensure a weather-tight condition. For sloped roofs, the roof curb shall be sloped to match the roof slope to provide a level unit support. The roof curb shall be consistent with the footprint of the unit, including the piping cabinet and other unit components.

B. Minimum 2” continuous internal insulation.

2.5 Refer to 23 34 00 HVAC Fans for roof curb requirements associated with that equipment.

PART 3 - EXECUTION

3.1 Attachment to manufactured trusses, joists, purlins, and other engineered structural members and supports shall be done in strict accordance with the structural engineer’s or manufacturer’s recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural engineer or manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances. In the case of existing trusses, the structural engineer must review and approve hanger attachment methods.

END OF SECTION

23 05 49 VIBRATION CONTROL FOR HVAC

PART 1 - GENERAL

1.1 Vibration isolators shall be provided at equipment as shown on the drawings and as herein specified.

1.2 The supplier of isolation equipment shall study the application, the equipment to be isolated and the structure. The supplier shall assume responsibility to determine required minimum deflections and optimum deflection characteristics accounting for dynamic and static forces.

PART 2 - PRODUCTS

2.1 Following is a description of the various types of isolators, bases and rails required. Catalog designations are those of Mason Industries.

Type J1
Hanger rod vibration isolator with combination steel spring and neoprene-in-shear isolators. Series 30N.

2.2 Springs shall have a minimum additional travel to solid equal to 30 percent of the rated deflection.

2.3 Vibration isolators installed outside shall be furnished weather-protected with springs PVC coated and other ferrous parts hot dip galvanized or cadmium plated.

2.4 Vibration isolators under equipment with significant water content (cooling towers, chillers, etc.) and equipment outside subject to wind loading shall be furnished with integral vertical limit stops.

2.5 Isolators shall be as manufactured by Mason Industries, Kinetics, Vibro-Acoustics, Amber Booth, Vibration Eliminator. All isolators shall be of one manufacturer.

PART 3 - EXECUTION

3.1 Manufacturer’s instructions shall be followed carefully in setting and adjusting vibration isolators. Ensure that no direct hard surface to surface contact exists. Fasten to the building structure as recommended by the isolation supplier.

3.2 Where electrical connections are made to equipment mounted on isolators, caution the Electrical Contractor to connect thru flexible conduits.

END OF SECTION

23 05 53 IDENTIFICATION OF HVAC EQUIPMENT

PART 1 - GENERAL

1.1 Identification of Division 23 equipment shall consist of equipment labeling, duct marking and valve tagging as specified hereinafter.

1.2 Each item of major equipment shall be labeled. This shall include rooftop units, fans, condensate drainage, refrigerant, and other similar equipment.

1.3 Duct markings shall be applied to all ductwork.

1.4 Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

1.5 Equipment and device identification specified in other sections shall be provided as a part of those requirements.

1.6 Submit product data noting materials, sizes and dimensions for identification systems.

PART 2 - PRODUCTS

2.1 Equipment labeling shall be either, or a mix, of the following:

A. Permanently attached engraved brass or plastic laminated signs with 1 inch high lettering. Signs on exterior equipment shall be brass.

B. Stencil painted identification, 2 inches high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 Duct markings shall be laminated plastic color-coded pressure sensitive vinyl tape, 2.50 inches width, 3 mils minimum thickness. Identification shall include service (supply, return, exhaust, outside air) and direction of flow.

2.3 Duct access door and panel markings shall be similar to duct markings to identify the device (FIRE DAMPER, SMOKE DAMPER, FIRE/SMOKE DAMPER, CONTROL DAMPER, SMOKE DETECTOR, etc.).

2.4 Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen, Kolbi, MSI or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 Identification labeling, marking and tagging shall be applied after insulation and painting has been completed.

3.2 Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled on drawings.

3.3 The Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.

3.4 Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust fan labeling shall also indicate service or room or area of service.

3.5 Duct markers shall be placed:

A. At each piece of equipment.

B. At 25 ft. centers in mechanical rooms and concealed spaces, but at least once per room.

C. At 50 ft. centers in exposed finished areas, but at least once per room.

D. On mains at each branch take-off.

E. On duct access panels.

END OF SECTION

23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 Provide air balancing of the new systems. Balancing work shall be performed by Kahoe, EnviroAire Total Balance Co, or American Air Balance. They shall be qualified personnel of a member firm of the Associated Air Balance Council (AABC) or a member firm of the National Environmental Balancing Bureau (NEBB), who has no affiliation with the Contractor or any of its Sub-Contractors. Include a certification sheet signed and sealed by the certified testing and balancing authority. Include a list of, instruments to be used for procedures, along with proof of calibration.

1.2 Methods, procedures, equipment, certifications, report forms and reporting information shall be in accordance with the standards of AABC or NEBB and latest edition of the SMACNA TAB Procedural Guide and industry practice.

1.3 During the bid period, call to attention any requirements for additional balancing dampers, test ports, gage cocks, thermometer wells, flow control devices, valves, balancing valves and fittings and manual volume dampers which are deemed necessary in addition to those shown on the drawings, and provide such so that proper balancing can be performed. Prior to installation of the systems, verify that the proper number and location of balancing devices are adequate for completion of the balancing work.

1.4 Prepare a balancing plan that includes strategies and step-by-step procedures. This plan should include a list of items that must be completed before balancing can proceed. Prepare a schedule to ensure adequate time for the balancing process and submit this schedule to the Architect or Construction Manager for review.

1.5 When project is in phases and partial occupancy is planned, determine process to allow balancing work to be completed before occupancy.

1.6 Refer to Section 23 05 31 HVAC Equipment Drives and other Sections of Division 23 for requirements related to the balancing work.

1.7 Verify that all equipment start-up services have been completed before the beginning of any balancing work. After initial start-up has been completed, inform the balancer that the systems are operating properly, that all safety interlocks and protective devices are functioning, and the systems are ready to be balanced. **Refer to SMACNA Guide 2.6.1 for items to be included in system check.**

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Air Balance

A. Obtain job specific fan curves for each fan being balanced, and include in report.

B. Record nameplate data from fan, motor, and air handling cabinet.

C. Record and measure fan and motor sheaves indicating number and size of belts along with center-to-center distances.

D. Test and record actual operating fan rpm.

E. Measure and record actual running amperage.

F. Each air supply, return, and exhaust system, when installation is completed, including the installation of clean filters, shall be set in operation for balancing. Determine the best location in main and branch ducts for accurate duct airflow measurements. Each air outlet and inlet device, item of equipment (fan coils, air control units, etc.), shall be balanced to the quantities listed on the drawings within plus or minus 10 percent, except when more stringent requirements are required as defined below. Central fan systems (AHU's, exhaust fan systems, etc.) shall be balanced to within plus or minus 5%. Intended pressure relationships in areas required by recognized standards and practice shall be attained.

G. Adjust drive pulleys to attain fan speed required for the installed condition. Pulleys and belts of fixed drives and of adjustable drives not having sufficient adjustment range shall be changed out, at the direction of the balancer or Engineer, to obtain fan speed required for the installed condition. Labor /or materials required to make the recommended changes shall be included in Division 23.

H. Measure velocity reading across coils, filters, and dampers on the intake side of the fan. Include data in the report.

I. Coordinate with the Temperature Controls Installer in setting supply and return fan inlet vanes, drives, outside air, return air and vent air dampers. Supply air systems shall have ampere reading measured in the full heating, full cooling and economizer modes to determine the maximum brake horsepower.

J. Witness all duct pressure and leakage tests. Refer to 23 31 13 and coordinate accordingly.

K. Total air quantities of the supply fan shall be determined by pitot tube traverse. Where impossible to take good pitot tube traverses of duct system, use total sum of terminal device air volume readings. Final settings of fan speeds shall be determined with automatic volume control devices at the fans fully open / variable speed drives at full speed. Refer to item F. above for drive changeout requirements and the items below.

L. Check airflow patterns from the outside-air louvers and dampers and the return and exhaust-air dampers, through the supply-fan discharge and mixing damper. Report any issues with stratification, poor mixing or short circuiting from one air stream to the other.

M. Check for airflow blockages.

N. Check for proper sealing of air-handling unit components. Report all issues in balancing report.

O. Check for proper sealing of air duct systems. Minor issues shall be reported in the balancing report. If a major issue is found, stop balancing work and report issue to the Construction Manager.

P. Balancing of air devices shall be done to provide adequate but not excessive pressure in the branch ducts to air control units and air devices. Dampers incorporated in air devices shall be used only as secondary balancing means when other branch dampers are provided. Check, test and calibrate as required all terminal air control unit cfm settings (maximum, minimum). Also, record static pressure drop across the air control unit and reheat coil.

Q. The report shall include, but not be limited to, fan curves, both actual and design fan cfm, rpm, brake HP, entering and leaving static pressures, motor data, voltage and amperage and drive information. System air flows by device, terminal, branch and system shall be reported.

In addition, a sketch shall be provided for each air system balanced or surveyed, depicting exact location that fan static pressure and fan CFM readings were taken, relative to fan inlet and discharge, and what duct accessories were in place near the reading location and between the reading location and the fan. The sketch shall also depict elbows and other duct transitions in place near the reading location and between the reading location and the fan. Air handling unit sketches shall depict all air path components with-in the unit, and static pressure readings across each item. Balance reports will be rejected without this information.

R. Mark equipment and balancing device setting with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-controls levers, and similar controls and devices, to show final setting.

3.2 After completion of the balancing work, a full report shall be prepared in pencil and two copies (only) submitted to the Engineer for preliminary review. After review, additional balancing, adjustments, drive replacements, readings and recordings deemed necessary shall be done and the report revised. Six typed copies of the final report shall be submitted to the Engineer for review and approval. An approved copy of the report shall be included in each set of operating and maintenance manuals.

3.3 Final Report contents: In addition to certified field report data, include the following:

A. Table of Contents with total number of pages defined for each section of the report.

B. Summary of Contents - include the following:

1. Indicated versus final performance.
2. Notable characteristics of systems.
3. Description of system operation sequence if it varies from the contract documents.

C. Nomenclature sheets for each item of equipment.

D. Notes to explain why certain final data in the body of reports varies from indicated values.

E. Fan Curves.

F. Manufacturers' test data.

3.4 Inspection after testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance reading documented in the final report. Submit random sampling percentages and results.

END OF SECTION

23 07 13 DUCT INSULATION

PART 1 - GENERAL

1.1 All interior supply air, mixed air, and intake outside air ductwork and plenums shall be insulated unless specifically noted as “uninsulated” in the Duct Construction Schedule on the drawings, including ductwork in crawl spaces, attics, and buried under slab.

1.2 All interior and exterior return air ductwork and plenums shall be insulated unless specifically noted as “uninsulated” in the Duct Construction Schedule on the drawings, including ductwork in crawl spaces, and attics (when duct is above the roof insulation).

1.3 Unless noted otherwise below, exhaust and relief air ductwork shall be insulated from 24” upstream of the auto/backdraft damper to the point of exterior wall/roof penetration, or as noted on the Duct Construction Schedule on the drawings.

1.4 Equipment and devices, accessories and stiffeners in insulated ductwork shall also be insulated. This includes but is not limited to external duct bracing and stiffeners. The backside of supply air diffusers shall also be insulated to prevent condensation, except if the air device is internally lined or factory insulated.

1.5 Required internal lining is indicated on the Duct Construction Schedule on the drawings. Refer to Section 23 31 13 - HVAC Ductwork and coordinate with the various trades.

1.6 Composite insulation assemblies shall meet UL 723 or ASTM E84 requirements and not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, and “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84. Identification of manufacturer, thermal resistance (R-value), flame spread and smoke-development shall be clearly marked on the exterior of the insulation at intervals as required by code.

1.7 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.8 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage, in addition to storing in original wrapping.

PART 2 - PRODUCTS

2.1 Insulation shall be manufactured by Johns Manville, Owens Corning, Certainteed, Knauf, Manson, or as listed below. Insulation for duct systems required to be insulated shall have a minimum installed R-value of 4.2.

2.2 Insulation on concealed ductwork shall be fiberglass blanket insulation with factory applied reinforced foil and kraft paper vapor barrier jacket, minimum 1.50 inches thickness and 0.75 inch

p.c.f. density, formaldehyde-free or GreenGuard Certified for low formaldehyde and VOC emissions.

PART 3 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of ductwork and fittings has been completed prior to installing insulation.

3.3 Installation

A. Installation shall be done by tradesmen specializing in this work in strict accordance with manufacturer's recommendations.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices. External duct stiffeners and bracing shall be insulated same as for duct.

C. Blanket insulation shall be wrapped tight to the duct. Insulation shall be secured to ducts 20 inches wide and greater with weld pins and fasteners, 18 inches on center maximum. Adhesive shall be applied to the duct as an aid to installation and adhesion. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3 inches wide FSK pressure sensitive tape.

D. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. All staples used on cold insulation shall be coated with suitable sealant to maintain vapor barrier integrity.

E. Externally insulate the backsides of supply air devices that are mounted in ceilings and not internally insulated.

3.4 Protection

A. Advise as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

END OF SECTION

23 07 19 HVAC PIPE INSULATION

PART 1 - GENERAL

1.1 Piping systems shall be insulated as described below in their entirety, including pipe, fittings, unions, flanges, mechanical joint couplings, pump casings, air and/or dirt separators, valves, devices, specialties and all related items and equipment unless otherwise noted. Maintain access to covered P/T test ports, strainer caps, air vents, and similar accessories thru the use of removable and reusable caps, plugs and fittings.

1.2 Composite insulation assemblies shall not exceed maximum flame spread of 25 and smoke development of 50, except as specifically allowed below, as established by UL 723 or ASTM E84 test methods. However, “discrete” combustible components as defined by the mechanical code may be UL 2043 listed in lieu of UL 723 or ASTM E84.

1.3 The following HVAC piping shall be covered with insulation of thickness listed, to meet or exceed ASHRAE 90.1, latest publication:

Pipe System	.75” and smaller	1.0” to 1.25”	1.50” to 3”
Refrigerant suction	1”	1.50”	1.50”
Refrigerant hot gas	1”	1”	1”
Refrigerant liquid (2)	1”	1”	1”
Cooling condensate drainage (1)	0.50”	0.50”	0.50”

Notes:
(1) Cooling condensate drainage – from cooling coil drain pans, associated floor drain sumps, traps and horizontal above ground piping to vertical stack (coordinate with plumbing).
(2) Insulate refrigerant liquid line when recommended or required by equipment manufacturer (such as for variable refrigerant volume / flow systems).

1.4 In addition to above, protective metal jacketing shall be provided on insulation on exterior refrigerant piping located on roof.

1.5 Submittals

A. Submit product description, thermal characteristics and list of materials and thickness for each service and location.

B. Submit manufacturers published literature indicating proper installation procedures.

1.6 Delivery, Storage and Handling

A. Materials on site shall be stored in original factory packaging, labeled with manufacturer’s identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical and damage in addition to storing in original wrapping.

2.1 Thermal conductivity (k) of pipe insulation shall be as specified below:

Maximum Conductivity k BTU in / (h x ft^2 x °F)	Mean Rating Temp degrees F
0.34	250
0.32	200
0.30	150
0.29	125
0.28	100

2.2 Refrigerant piping and cooling condensate systems shall be insulated with closed cell elastomeric or cellular glass. Fiberglass is not permitted. Outdoor piping shall be jacketed as described below.

2.3 Cellular glass insulation shall be molded pipe insulation, Pittsburgh Corning “FOAMGLAS” or approved equal, rated for intended service, thermal conductivity (k) of no greater than 0.29 at 75 degrees F mean rating temperature. Fittings shall be insulated with machined segments of pipe insulation or block or board stock. Joints shall be sealed with vapor sealing adhesive per manufacturer’s instructions. For direct-buried systems, jacketing shall be 70 mil self-sealing bituminous membrane equal to “Pittwrap SS”. For exterior above grade systems, jacketing shall be Pittcoat 300, protected with an external metal jacket. For indoor systems, insulation shall include an all service jacket, PittSeal 444 on all joints and seams, with the assembly meeting ASTM E84 25/50 flame and smoke requirements.

2.4 Closed cell elastomeric insulation for above grade use on systems operating at 200 degrees F and below and 6 inches or smaller pipe sizes shall be tubular closed cell pipe insulation, pre-slit longitudinally. Polyolefin insulation is not acceptable. Insulation shall be manufactured without the use of CFC’s, HCFC’s or HFC’s. It shall meet ASTM C534 and also be formaldehyde free, low VOC, dust free, resistant to mold and mildew, and shall be 25/50 rated per ASTM E84. Thermal conductivity (k) shall be maximum 0.27 at 75 degrees mean rating temperature.

Closed cell elastomeric insulation shall be Armacell AP/Armaflex SS, K-Flex USA “Insul-Tube” or Aero Flex USA “Aerocel-SSPT”. For systems operating at 180 degrees F or less, insulation shall utilize a self-sealing pressure sensitive closure system. Butt joints shall be sealed with Armaflex 520 BLV low VOC adhesive or equal. For systems operating between 180 degrees F and 200 degrees F, all joints and seams shall be sealed with Armaflex 520 BLV low VOC adhesive or equal.

For indoor systems, use shall be restricted to those systems requiring 2 inch thickness or less (due to 25/50 ASTM E-84 requirements).

Unless jacketed, for insulation located outside field paint with minimum 2 coats of an appropriate paint as recommended by the insulation manufacturer to prevent solar ultra-violet deterioration.

2.5 Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with any of the following (except when removable insulation covers are specified):

C. For closed cell elastomeric insulation systems:

1. Miter cutting of tubular insulation using special tools and mitering devices; or
2. Oversized pipe insulation overlapped and shaped to conform to fitting, valve or device.

D. For cellular glass insulation systems:

1. Machined or factory fabricated segments.
2. Hand carved, subject to approval by the Engineer.

2.6 Hangers on insulated horizontal piping are to be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:

A. Pipe 2 inches and smaller Anvil Fig. 168, 18 ga. sheet metal rib-lock shield with belled ends, 12 inches long.

2.7 Insulation saddles shall be compatible with pipe insulation materials and thicknesses. Vapor barrier shall be continuous.

2.8 For systems specified to have protective jacketing, jacketing shall be 0.016 inch aluminum with special Z-joint closure and factory supplied snap-straps. Joints and seams shall be sealed watertight.

PART 2 - EXECUTION

3.1 Site Inspection

A. Before starting work, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of insulation materials and accessories can begin.

B. Verify that all insulation materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all insulation materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.2 Preparation

A. Ensure that all surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping and fittings has been completed prior to installation.

3.3 Installation

A. Installation shall be done by tradesman specializing in insulation work in strict accordance with manufacturers' recommendations. Installers shall be factory trained and certified for the insulation systems being installed. Submit credentials upon request.

B. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices.

C. Install insulation on piping subsequent to installation of heat tracing and acceptance tests.

D. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services.

Vapor barrier type mastic shall be used where needed to maintain a vapor seal, including over staples.

E. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic. Except in ceiling spaces, PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.

F. Insulation on cold service piping shall be run thru floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the 23 05 07 Piping Materials and Methods for special considerations which must be given at fire rated wall and floor penetrations. Refer to Section 23 05 29 Hangers and Supports for HVAC Piping for non-compressible insulation or blocking material and sheet metal saddles required at pipe hangers. Refer to Section 23 05 23 General Duty Valves for HVAC Piping for valves requiring extended shaft necks. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.

G. Provide removable insulation sections to cover parts of equipment which must be opened periodically or maintenance, and for cooling condensate piping clean-outs.

H. Items such as ASME stamp and manufacturers' nameplates, may be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of those items. Provide neatly beveled edges at interruptions of insulation.

3.4 Protection

A. Advise as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

B. Replace damaged insulation, which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

3.5 Safety Precautions

A. Employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats and eye protection.

B. Conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

END OF SECTION

23 08 00 COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 Refer to specification Section 01 91 00 – Commissioning for the detailed responsibilities of all parties as it relates to the project. All Contractors shall fully participate in the commissioning process including managing their related documentation using the online Commissioning Documentation Database described in Section 01 91 00.

1.2 Responsibilities

A. The responsibilities of various parties in the commissioning process are identified in Section 01 91 00. Additional responsibilities related to Division 23 systems are identified herein.

B. The Construction Manager (CM) shall:

1. Facilitate the coordination of the commissioning work by the CxA. The CM and CxA ensure that commissioning activities are being scheduled into the master schedule.
2. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
3. Ensure that all Contractors execute their commissioning responsibilities according to the Contract Documents and schedule.
4. Attend the commissioning scope meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
5. Observe and witness Construction, Construction and Startup checklists, Startup, and Functional testing of selected equipment.
6. Review commissioning progress and deficiency reports/issues logs and resolve items in an expeditious manner.
7. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
8. Coordinate the training of owner personnel.

C. Each Contractor shall:

1. Coordinate the commissioning work with the CxA.
2. Execute their commissioning responsibilities according to the Contract Documents and schedule.
3. Attend the commissioning scope meeting(s) and other necessary meetings scheduled by the CxA to facilitate the Cx process.
4. Participate in control software review meeting. The meeting is for walk-thru systems and sequences with the CxA, after the temperature control submittals are approved. Review trending and monitored data requirements.
5. Controls Installer shall run a 4-day trending of selected equipment prior to functional testing. If functional testing does not pass, after the issues are resolved and checked off by the CxA, the Controls Installer will again run a 4-day trending of selected equipment.
   a. The trending data shall be provided in one of the following formats: .csv, .txt, or .xls
   b. The trending data shall consistently be delimited by either tab, semicolon, comma, or space. If the data is not delimited, it shall be pre-configured in an .xls file with each data point in a separate cell.
   c. All trend points must be labeled clearly and intuitively.
6. Controls Installer shall provide access to the control’s platform for the purpose of commissioning, including access to all graphics, trending, and interfaces.
7. Include all special tools and instruments (only available from the vendor, specific to a piece of equipment) required for operational and functional testing equipment according to these Contract Documents in the base bid price to the Contractors.

8. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
9. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.
10. Observe and witness construction, construction and startup checklists, startup, and functional testing of selected equipment.
11. Review commissioning progress and deficiency reports/issues log and resolve items in an expeditious manner.
12. Resolve the non-compliance and design deficiencies identified in all phases of commissioning.
13. Coordinate the training of Owner personnel for the systems provided under this contract.
14. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
15. Review test procedures for equipment started up by factory representatives.
16. Provide the necessary information for their trade as outlined in Section 01 91 51.

1.3 Division 23 Systems to be Commissioned

A. The following systems shall be commissioned in this project.

1. Mechanical Systems

a. Air Rotation Units
b. DOAS/Ventilation
c. Exhaust Fans
d. DDC - Front End and Integration

PART 2 - PRODUCTS

2.1 Test Equipment

A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the Contractors for the equipment being tested.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, shall be included in the Contractors bid price.

C. All testing equipment shall be of sufficient quantity, quality and accuracy to test and/or measure system performance. All equipment shall be calibrated within the last year, and according to the manufacturer's recommended intervals, and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

D. The Contractor shall provide written documentation to the CxA that the Contractor's staff has been trained on the proper use and application of any testing equipment.

PART 3 - EXECUTION

3.1 Construction Checklists, Start-Up Checklists, and Initial Checkout

A. The following procedures apply to all equipment to be commissioned, as listed in Systems to be Commissioned. Some systems that are not comprised of actual dynamic machinery may have very simplified CCs, SCs and startup.

B. Startup and Initial Checkout Plan. The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed startup plans for all equipment.

The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for construction and startup checklists are identified in the commissioning orientation meeting and in the checklist forms.

1. The CxA provides these checklists and tests to the Contractors. The Contractors determines which trade is responsible for executing and documenting the tests.
2. The Contractor responsible for the purchase of the equipment develops the full startup plan by combining (or adding to) the CxA's checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. Where required, the equipment shall be started up by factory representatives. The CxA shall be notified a minimum 48 hours prior to equipment startup.
3. The Contractor submits the full startup plan to the CxA for review.
4. The CxA reviews the procedures and the format for documenting them, noting any procedures that need to be added.

C. Sensor and Actuator Calibration

1. All field-installed sensors, gages, and actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the CxA beforehand. All test instruments shall be within a certified calibration within the previous 12 months. Sensors installed on equipment at the factory with calibration certification provided, need not be field calibrated.
2. All procedures used shall be fully documented on the construction and startup checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
3. Sensor Calibration Methods
   a. All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2 degrees F of each other for temperature and within a tolerance equal to 2 percent of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
   b. Sensors without Transmitters -- Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent meter, gage or direct digital control system (DDCS) is within the tolerances in the table below of the instrument-measured value. If not, install offset in DDCS, calibrate or replace sensor.
   c. Sensors with Transmitters -- Standard Application. Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and DDCS control panel. Using manufacturer's resistance-temperature data simulate minimum desired temperature. Adjust transmitter potentiometer zero until the ammeter reads 4 mA. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the DDCS. Record all values and recalibrate controller as necessary to conform to specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or DDCS) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
   d. Critical Applications. For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.
4. Tolerances, Standard Applications

Sensor	Required Tolerance (+/-)	Sensor	Required Tolerance (+/-)
Cooling coil, chilled and condenser water temps	0.4F	Flow rates, water	4% of design
		Relative humidity	4% of design
AHU wet bulb or dew point	2.0F	Combustion flue temps	5.0F
Hot water coil and boiler water temp	1.5F	Oxygen or CO_2 monitor	0.1 % pts
Outside air, space air, duct air temps	0.4F	CO monitor	0.01 % pts
Watt-hour, voltage & amperage	1% of design	Natural gas and oil flow rate	1% of design
Pressures, air, water and gas	3% of design	Steam flow rate	3% of design
Flow rates, air	10% of design	Barometric pressure	0.1 in. of Hg

5. Valve and Damper Stroke Setup and Check
   a. DDCS Readout. For all valve and damper actuator positions checked, verify the actual position against the DDCS readout.
   b. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or adjust.
   c. Closure for heating coil valves (NO): Set heating setpoint 20 degrees F above room temperature. Observe valve open. Remove control power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 20 degrees F below room temperature. Observe the valve close. Restore to normal.
   d. Closure for cooling coil valves (NC): Set cooling setpoint 20 degrees F above room temperature. Observe the valve close. Remove control power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20 degrees F below room temperature. Observe valve open. Restore to normal.

D. Execution of Construction and Startup Checklists, and Startup

1. The Contractors and vendors schedule startup and checkout with the CM, PM and CxA. The performance of the construction and startup checklists, startup and checkout are directed and executed by the Contractors or vendor. When checking off construction and startup checklists, signatures may be required of other Contractors for verification of completion of their work.
2. The CxA shall observe, at minimum, the procedures for each piece of primary equipment. In no case shall the number of units witnessed be less than the contractual agreement on any one building.
3. For lower-level components of equipment, (e.g., VAV boxes, sensors, controllers), the CxA shall observe a sampling of the construction, and startup, and startup procedures.
4. The Contractors and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed startup, and construction and startup tests and checklists.
5. Only individuals that have direct knowledge and witnessed that a line item task on the construction and startup checklist was actually performed shall initial or check that item off. It is not acceptable for supervisors to fill out these forms.

E. Deficiencies, Non-Conformance and Approval in Checklists and Startup

1. The Contractors shall clearly list any outstanding items of the initial startup and construction and startup procedures that were not completed successfully, and any completed corrections, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Contractor or CM. The CxA shall work with the Contractors and vendors to correct and retest deficiencies or uncompleted items. The CxA shall involve the CM and others as necessary. The installing Contractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated startup report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and start-up of each system.
3. Items left incomplete, which later cause deficiencies or delays during functional testing will result in incidental damages to the responsible party.

3.2 HVAC Data Trending Process

A. The Contractor shall provide graphical trending through the DDC control system of systems being commissioned. Trending requirements are indicated below. Trending shall occur before, during, and after Systems Functional Performance Testing. The Contractor shall be responsible for producing graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the System Functional Testing. These graphical reports shall be submitted to the Commissioning Agent for review and analysis before, during dynamic operation, and after Systems Functional Performance Testing.

B. The Contractor shall also provide trending data files downloaded from the DDC control system of systems being commissioned. The trending data shall be provided in one of the following formats: .csv, .txt, or .xls. The trending data shall also consistently be delimited by either tab, semicolon, comma, or space. If the data is not delimited, it shall be pre-configured in an .xls file with each data point in a separate cell.

C. In the event the specified document system does not have sufficient data storage to achieve the trending requirements specified herein, it is the Contractors responsibility to provide temporary data storage to facilitate Cx activities.

D. The Contractor shall provide, but not limited to, the following trend requirements and trend submissions:

1. **Pre-Testing, Testing, and Post-Testing** - Trend reports of trend logs and graphical trend plots are required as defined by the Commissioning Agent. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the Commissioning Agent. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the CM. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the CM, prior to the execution of Systems Functional Performance Testing.
2. **Dynamic Plotting** - The Contractor shall also provide dynamic plotting during Systems Functional Performance testing at frequent intervals for points determined by the Systems Functional Performance Test Procedure. The graphical plots will be formatted and plotted at durations listed in the Systems Functional Performance Test Procedure.

3. **Graphical Plotting** - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be sufficiently accomplished directly in the Direct Digital Control System, then plot these trend logs in Microsoft Excel.
   The tables in Attachment A indicate the points to be trended and alarmed by the system. The Operational Trend Duration column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to Systems Functional Performance Testing and again after Systems Functional Performance Testing. The Type column indicates point type: AI=Analog Input, AO= Analog Output, DI= Digital Input, DO=Digital Output, Calc = Calculated Point. In the Trend Interval Column, COV= Change of Value. Stated by the Commissioning Agent. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the CM. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the CM, prior to the execution of Systems Functional Performance Testing.

E. Contractor is responsible to upload all trend information, formatted in graphical form as a pdf file and formatted in a data file as described above, to the Cx documentation database.

3.3 Functional Performance Testing (FT)

A. Objectives and Scope. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the OPR and the Contract Documents. During the testing process, areas of deficient performance are identified and shall be corrected, improving the operation and functioning of the systems.

B. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each step in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.

C. Development of Test Procedures. Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor or vendor responsible to participate in the execution of a test shall provide limited assistance to the CxA in developing the procedures review. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractors who shall review the tests for feasibility, safety, equipment and warranty protection via the Cx documentation database. When requested, the CxA will submit the tests to the A/E for review.

   The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

   The test procedure forms developed by the CxA shall include (but not be limited to) the following information:

   1. System and equipment or component name(s)
   2. Equipment location and ID number

3. Unique test ID number, and reference to unique construction and startup checklist and startup documentation ID numbers for the piece of equipment
4. Date
5. Project name
6. Participating parties
7. A copy of the specific sequence of operations or other specified parameters being verified
8. Required pre-test field measurements
9. Instructions for setting up the test
10. Special cautions, alarm limits, etc.
11. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
12. Acceptance criteria of proper performance with a check box to allow for clearly marking whether or not proper performance of each part of the test was achieved
13. A section for comments
14. Signatures and date block for the CxA

D. Test Methods

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone dataloggers. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified. The CxA shall determine which method is most appropriate for tests that do not have a method specified.
2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible.
4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
5. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. These verifications shall be completed during construction and startup testing.
7. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractors shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
8. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. **It is noted that no sampling by Contractors is allowed in construction and startup checklist execution**.

E. Coordination and Scheduling. The Contractors shall provide sufficient notice to the CxA regarding their completion schedule for the construction and startup checklists and startup of all equipment and systems. The CxA shall schedule functional tests through the CM and affected Contractors. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractors shall execute the tests.

In general, functional testing is conducted after construction and startup testing has been satisfactorily completed. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

The Contractor shall provide access to the controls system for the purpose of commissioning; including access to all graphics, trending, and interfaces.

F. Test Equipment. Refer to Part 2 for test equipment requirements.

G. Problem Solving. The CxA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, Contractors and A/E.

H. Prior to indicating that equipment or systems are ready for functional testing, the Contractor shall have independently completed the pre-functional test with successful result.

3.4 Documentation, Non-Conformance and Approval of Functional Tests

A. Documentation. The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the CM for review and approval and to the Contractors for review. The CxA shall include the completed forms in the final Cx report and Current Facilities Requirements report.

B. Non-Conformance

1. The CxA shall record the results of the functional test on the procedure or test form using the Cx documentation database. All deficiencies or non-conformance issues shall be noted and reported to the CM on a standard non-compliance form and the Cx database issues log.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution shall be documented on the procedure form.
3. As tests progress and a deficiency are identified, the CxA discusses the issue with the executing Contractors.
    a. When there is no dispute on the deficiency and the Contractors accepts responsibility to correct it:
        1) The CxA documents the deficiency and the Contractors response and intentions and they go on to another test or sequence. The Contractors corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested via the Cx documentation database.
        2) The CxA reschedules the test and the test is repeated. See sub-item 3.5.B.4...
    b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
        1) The deficiency shall be documented on the non-compliance form with the Contractors' response and a copy given to the CM and to the Contractors' representative assumed to be responsible.

2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the owner's representative.
3) The CxA documents the resolution process. The CxA will test equipment once and provide one re-test; additional cost associated with further required re-testing of the same equipment shall be borne by the responsible Contractors.
4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.

4. Cost of Retesting
   a. The cost for the Contractor/Sub-Contractor to retest a construction and startup or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the CM.
   b. Owner will compensate CxA / A/E for attending and directing additional testing.
   c. Owner will deduct additional testing compensation from final payment due to Contractors.
   d. For a deficiency identified, not related to any construction and startup checklist or startup fault, the following shall apply: The CxA and CM shall direct the retesting of the equipment once at no "charge" to the Owner for their time. However, the CxA's and CM's time for a second retest shall be charged to the Contractor.
   e. The time for the CxA and CM to direct any retesting required because a specific construction and startup checklist or startup test item, reported to have been successfully completed, but determined during functional testing to be faulty, shall be the responsibility of the contractor.
   f. Refer to the sampling section of Para. 3.5 for requirements for testing and retesting identical equipment.
5. The Contractors shall respond via the Cx documentation database to the CxA and Owner on a 48-hour basis concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
6. The Contractors shall not consider any required retesting caused by any Contractors a justified reason for a claim of delay or for a time extension.

C. Failure Due to Manufacturer Defect. If 10 percent, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the PM. In such case, the Contractors shall provide the Owner with the following:

1. Within one week of notification from the CM or PM, the Contractors or manufacturer's representative shall examine all other identical units, making a record of the findings. The findings shall be provided to the CM or PM within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractors or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. The PM shall determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples of the proposed solution shall be installed by the Contractors and the CM shall be allowed to test the installations for up to one week, upon which the PM shall decide whether to accept the solution.
5. Upon acceptance, the Contractors and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment

warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

D. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA. The CxA recommends acceptance of each test to the PM using a standard form. The CxA gives final approval on each test using the same form, providing a signed copy to the Contractors.

3.5 Operation and Maintenance Manuals

A. Standard O&M Manuals

1. The specific content and format requirements for the standard O&M manuals are detailed in specifications.

3.6 Training of Owner Personnel

A. The CM shall be responsible for training and scheduling and ultimately ensuring that training is completed.

3.7 Deferred Testing

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties shall be negotiated. Equipment that does not initially pass deferred functional testing shall have the warranty start date adjusted to date of passing test completion.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests shall be executed, documented and deficiencies corrected by the appropriate Contractors, with facilities staff and the CxA witnessing. Equipment that does not initially pass seasonal functional testing shall have the warranty start date adjusted to date of passing test completion. Any final adjustments to the O&M manuals and as-builts due to the testing shall be made.

3.8 Written Work Products

A. The commissioning process generates a number of written work products described in various parts of the specifications. In summary, the written products are:

Product	Developed By
1. Final commissioning plan	CxA
2. Cx Meeting minutes	CxA
3. Commissioning schedules	CxA with CM
4. Equipment documentation submittals	Responsible Installing Contractors
5. Sequence clarifications	Responsible Installing Contractors and A/E as needed
6. Construction and startup checklists	CxA (included in Specifications)
7. Startup and initial checkout plan	Responsible Installing Contractors and CxA (compilation of existing documents)
8. Startup and initial checkout forms filled out	Responsible Installing Contractors
9. Final Air and Water Balance Report	HVAC Contractor/Balancer

10. Commissioning Progress Record	CxA
11. Deficiency reports	CxA
12. Functional test forms	CxA
13. Trend Logs	Responsible Installing Contractor
14. Filled out functional tests	CxA
15. O&M manuals	Responsible Installing Contractors
16. Commissioning record book	CxA
17. Overall training plan	CM
18. Specific training agendas	Responsible Installing Contractors
19. Final commissioning report	CxA
20. Misc. approvals	CxA

END OF SECTION

23 09 23 BUILDING AUTOMATION SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 Overview

A. Furnish all labor, materials and equipment necessary for a complete and operating Building Automation System (BAS), utilizing direct digital controls and electric actuation as shown on the drawings and as described herein. Drawings are diagrammatic only.

B. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed over the control system network, the Owner's local area network, and remotely over the Internet (through the Owner's LAN).

C. Performance Monitoring: The BAS will provide the specified performance monitoring functionality, including required monitoring points and performance metrics, improved through system accuracy, data acquisition and data management capabilities, and required graphical and data displays.

D. The intent and requirement of this specification and related sections is to provide a fully integrated, open, interoperable, peer-to-peer, networked, and distributed BAS. The following communication protocols are acceptable:

1. ANSI/ASHRAE Standard 135 BACnet - A Data Communication Protocol for Building Automation and Control Networks
2. MODBUS Application Protocol V1.1b (applicable to factory packaged equipment controllers only)
3. Tridium Niagara Framework Protocol
4. Internet Engineering Task Force RFC 7540 Hypertext Transfer Protocol HTTP/2

E. The BAS shall be comprised of:

1. Communications Network
2. Enterprise Network Server
3. Embedded Controller/Web Server(s)
4. Graphical User Interface
5. Equipment controllers (B-AAC, B-ASC, MEC)
6. Sensors (refer to Section 23 09 25)
7. Controlled devices (refer to Section 23 09 25)

F. Software License Agreement

1. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract, and shall give him and their authorized agent full access to all features and functions of the installed BAS. Such license shall grant use of all programs and application software to Owner and their authorized agent as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.
2. It is the Owner's express goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project. In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This

shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the Enterprise Network Server, Embedded Controller/Web Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner. The owner shall determine which organizations to be named in the SI organization ID ("orgid") of all software licenses. All NiagaraAX or Niagara 4 software licences shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*"; "accept.wb.in=*"; "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier, by Tridium Inc.

G. All Embedded Controller/Web Servers shall be accessed via a single connection to the Enterprise Network Server. In this configuration, each Embedded Controller/Web Server can be accessed from a PC using Remote Desktop Connection Client User Interface and from a PC using Web Browser Client User Interface.

H. Local connections shall be via an Ethernet LAN. Remote connections shall be via Owner provided full-time, high-speed ISP connection for remote site access (i.e., T1, ADSL, cable modem) and IPv6 compliant. The owner shall be responsible for all monthly internet access fees and connection charges.

I. The basic control system includes all sensors, controllers, instruments, valves, actuators, devices, installation and service for a complete and functional control system. All control devices (valves, dampers, actuators, etc.) and associated power and control wiring shall be included. Refer to Section 23 09 25 Instrumentation and Control Devices for HVAC and Section 23 09 47 Control Power and Wiring for HVAC. The BAS shall be designed to allow easy field adjustment of all set points and parameters.

J. Provide for future system expansion to include monitoring of the access, intrusion detection, fire alarm, and lighting control systems.

1.2 Provider Requirements

A. Manufacturer Qualifications

1. All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. The installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be made available for at least 10 years after completion of this contract.

B. Installer Qualifications

1. Installing Contractor shall have an established working relationship with Control System Manufacturer of not less than 5 years.
2. Installing Contractor and their Sub-Contractors shall have successfully completed manufacturer's control system training. Provide certification of completed training, including hours of instruction and course outlines, within 10 days after bid date.
3. Installing Contractor shall have an office within 75 miles of the project site and provide 24 hour response in the event of a customer call, 7-days per week, 365 days per year.

1.3 Approved Control System Manufacturers and Installing Contractors

A. Enterprise Server and Embedded Controller/Web Server products utilizing Niagara Framework by Tridium Inc. are the basis of design.

B. Any material or equipment that will fully perform the duties specified will be considered 'equal,' provided the bid submits proof that such material or equipment is of equivalent substance and function and is approved, in writing. Requests for the approval of 'or equal' shall be made in writing at least five business days prior to bid opening. During the bidding period, all approvals shall be issued by the Architect/Engineer in the form of addenda at least two business days prior to the bid opening date.

C. Any Manufacturer or Installing Contractor not pre-qualified above shall submit credentials for the Engineer's review seven or more days prior to the bid date. Applications submitted after seven days prior to the bid date will not be considered. Credentials must attest that the manufacturer and installer meet all requirements above. The Engineer's judgment in reviewing any manufacturer or contractor will be final.

D. The following control system Manufacturers' products that are BACnet compliant are pre-qualified:

Pre-Approved Installers	**Pre-Approved Manufacturers**				
Dayton Market	**Distech Controls**	**Honeywell WEBs**	**JCI Facility Explorer**	**Lynxspring**	**Infocon EasyIO**
Point 2 Point Systems	X	X		X	X
Mechanical Systems of Dayton		X	X	X	
The Habegger Corporation		X			
Waibel Energy Systems/BuildingLogiX		X		X	X
EES Facility Services			X		
Wadsworth Solutions		X			
Local JCI Branch Office			X		

1.4 Technical Proposal

A. Provide a technical proposal to the Engineer after bidding and before award of a contract. The Engineer's review comments will be made available to the bidder two weeks after receipt of the technical proposal. The technical proposal shall contain the following:

1. Description of how the system meets and achieves the specified criteria in terms of configuration, operation and control.
2. BAS single line riser diagram, showing all major components (digital controllers, bus network, etc.).
3. Procedure and amount of time required to start up the system.
4. Bidder shall explain:
   a. How Owner programs (language, etc.) the system.
   b. Any proprietary software for which documentation is not available.
   c. Manufacturer of major components.
   d. Requirements of the off-site portable operator's terminal to access to BAS over internet communications.

B. For all application programs supplied, bidder shall explain in the technical proposal, program constraints and limitations, and listing of all systems the program is applied to, including digital controller interface and control of:
   1. Air handling unit.
   2. Exhaust fans.
   3. Make up air unit.
   4. CO/NO2 detection.

C. An interview may be conducted and each bidder will be requested to make a presentation concerning the system proposed.

1.5 Codes and Standards

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions of the following codes and standards:

   1. National Electric Code (NEC)
   2. Kentucky Building Code (OBC) and Kentucky Mechanical Code (OMC)
   3. National Fire Protection Association (NFPA)
   4. ANSI/ASHRAE Standard 55 Thermal Environmental Conditions For Human Occupancy
   5. ANSI/ASHRAE Standard 62 Ventilation For Acceptable Indoor Air Quality
   6. ANSI/ASHRAE Standard 90.1 Energy Standard For Buildings Except Low-Rise Residential Buildings
   7. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Networks
   8. Underwriters Laboratories: Products shall be UL-916-PAZX Listed

1.6 The following sections constitute related work:

A. Section 23 09 25 – Instrumentation and Control Devices for HVAC

B. Section 23 09 47 – Control Power Wiring for HVAC

1.7 System Performance

A. Performance Standards. System shall conform to the following minimum standards over network connections:

   1. Graphic Display. A graphic with 20 dynamic points/objects shall display with current data within 10 seconds.
   2. Graphic Refresh. A graphic with 20 dynamic points/objects shall update with current data within 8 seconds.
   3. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.
   4. Object Scan. Data used or displayed at a controller or user interface shall have been current within the previous 6 seconds.
   5. Alarm Response Time. An object that goes into alarm shall be annunciated at the user interface within 45 seconds
   6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 second. Select execution times consistent with the mechanical process under control.
   7. Performance. Programmable controllers shall be able to completely execute BAS PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.

8. Multiple Alarm Annunciations. Each user interface on the network shall receive alarms within 5 seconds of other user interfaces.
9. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1 of Section 23 09 25 Instrumentation and Control Devices.
10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2 of Section 23 09 25 Instrumentation and Control Devices.

1.8 Submittals

A. Refer to Section 23 05 01 – Basic HVAC Requirements.

B. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2009 (or newer) compatible files on optical disk (file format: .dwg, .dxf, .vsd, or compatible) with 11 inches x 17 inches prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Damper and valve schedules and data sheets may be submitted separately to improve product delivery dates. Provide submittals within 12 weeks after contract award, including the following:

1. BAS Hardware
   a. Complete bill of materials indicating quantity, manufacturer, model number, and other relevant technical data.
   b. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation and maintenance instructions for items listed below and for other relevant items not listed below:
      1) DDC (controller) panels
      2) Transducers and transmitters
      3) Sensors (including accuracy data)
      4) Actuators
      5) Valves
      6) Dampers
      7) Relays and switches
      8) Control panels
      9) Power supplies
      10) Batteries
      11) User interface equipment
      12) Wiring
   c. Wiring diagrams and layouts for each control panel. Show all termination numbers.
   d. Floor plan schematic diagrams indicating field sensor, controller and power supply locations.
2. Network and User interface Hardware and Software
   a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
   b. Manufacturer's description and technical data, such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
      1) Central Processing Unit (CPU)
      2) Monitors
      3) Keyboards
      4) Power supply

5) Battery backup
6) Interface equipment between CPU and control panels
7) Routers
8) Repeaters
9) Operating System software
10) User interface software
11) Color graphic software
12) Third-party software

c. Schematic diagrams of control, communication, and power wiring for central system installation. Label cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to control system.
d. List of color graphics to be provided. Provide a conceptual layout of pictures and data for each graphic, showing or explaining which other graphics can be directly accessed.

3. Controlled Systems
   a. Riser diagrams showing control network layout, communication protocol, and wire types.
   b. Schematic diagram of each controlled system. Label control points/objects with point/object names. Graphically show all locations of control elements.
   c. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
   d. Instrumentation list for each controlled system. List each control system element in a table format. Show element name, type of device, manufacturer, model number, and product data sheet number.
   e. Mounting, wiring, and routing plan view drawing in 0.25 inch scale. Take into account HVAC, electrical and other systems' design and elevation requirements. Show locations of concrete pads and bases and special wall bracing for panels to accommodate this work.
   f. Complete description of control system operation including sequences of operation. Include and reference a schematic diagram of system.
   g. Point/object list for each system controller including inputs and outputs (I/O), point/object numbers, controlled device associated with each I/O point/object, and location of I/O device. Indicate alarmed and trended points/objects.
4. Description of process, report formats, and checklists to be used in Part 3: "Control System Demonstration and Acceptance."
5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of BACnet controller (B-BC, B-AAC, B-AVAVC, B-ASC) and user interface (B-OWS).
6. Instrumentation and Data Point Summary Table. Contractor shall submit in table format with the following information for each instrument and data point. The table is to be reviewed and approved by the owner's representative prior to hardware and software installation and programming.
   a. Point name
   b. Point description: provide building designation, system type, equipment type, engineering units, and functionality; include a description of its physical location
   c. Expected range (upper and lower limit)
   d. Instrumentation (as applicable): manufacturer, model number, range, and accuracy specification
   e. Type
      1) AI: analog input
      2) BI: binary input
      3) NAI: network analog input
      4) NBI: network binary input
      5) P: programmed (e.g., soft or virtual point in control sequence such as a PID input or output)

6) C: calculated value; a soft or virtual point. If calculated value, provide logic diagrams or code and any constants used in formula. If time-based integrated values are required, provide time periods: minutes, daily, weekly, monthly, and yearly. Also indicate if it is a running average.

f. Input resolution
g. Graphic display resolution
h. Data trend interval
i. Number of samples stored in local controller before transfer to host computer/server database
j. Data point address

C. Schedules

1. Provide a Schedule of work within one month of contract award indicating:
   a. Intended sequence of work items
   b. Start date of each work item
   c. Duration of each work item
   d. Planned delivery dates for ordered material and equipment, and expected lead time
   e. Milestones indicating possible restraints on work by other trades or situations
2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

D. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

1. Project Record Drawings.
   a. As-built versions of the submittal shop drawings provided as PDF's and as 11 inches x 17 inches prints.
   b. Submittals to include complete electrical point-to-point wiring diagrams, component layouts, system and equipment component sequences of operation, start-up and checkout procedures. Include a list of all unit default safety and control settings, whether fixed or adjustable, as shipped from the factory. Where field modifications are required to meet the specification, provide all modification labor and materials, and submit a complete, detailed, step-by-step procedure for the modifications.
2. Testing and Commissioning Reports and Checklists. Completed versions checklists and trend logs used to meet requirements of Part 3: "Control System Demonstration and Acceptance."
3. Operation and Maintenance (O & M) Manual.
   a. As-built versions of the submittal product data.
   b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
   c. User's manual with procedures for operating control systems: logging on and off, handling alarms, producing point/object reports, trending data, overriding computer control, and changing setpoints and variables.
   d. Programming manual or set of manuals with description of the programming language and syntax of statements for algorithms and calculations used of point/object database creation and modification, of program creation and modification, and editor use.
   e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points/objects, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
   f. Documentation of all programs created using custom programming language including setpoints, tuning parameters, and object database.
   g. Graphic files, programs and database on magnetic or optical media.

h. List of recommended spare parts with part numbers and suppliers.
i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
j. Complete original-issue copies of furnished software, including operating systems, custom programming language, user interface software, and graphics software.
k. Licenses, guarantee, and warranty documents for equipment and systems.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

4. Training Materials: Provide course outline and manuals for each class at least six weeks before the first class. Engineer will modify course outlines and manuals if necessary to meet Owner's needs. Engineer will review and approve course outlines and manuals at least three weeks before first class.

1.9 Warranty

A. Warrant all work as follows:
1. Warrant labor and materials for specified BAS free from defects for a period of 18 months after final acceptance. BAS failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner. Respond during Owner's business hours within 24 hours of Owner's warranty service request.
2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
3. If Engineer determines that equipment and systems operate satisfactorily at the end of the final start-up, testing, and commissioning phase, Engineer will certify in writing that BAS operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Provide updates to user user interface software, project-specific software, graphic software, database software, and firmware which resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above mentioned items. Do not install updates or upgrades without Owner's written authorization.

1.10 Ownership of Proprietary Material

A. Project specific software and documentation shall become Owner's property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation

PART 2 - PRODUCTS

2.1 Materials

A. The equipment specified shall be provided as defined herein, shown on the drawings and as required to accomplish the sequences of control.

B. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site

unless explicitly approved in writing by Owner or Owner's Representative. Spare parts shall be available for at least five-years after completion of this contract.

2.2 BACnet Communications

A. Control products, communication media, connectors, repeaters, hubs and routers shall comprise a BACnet BAS. Controllers and user interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Each controller shall have a communication port for connections to an user interface.

C. Project drawings indicating remote buildings or sites to be connected to the Enterprise network shall allow for communication with each controller on the network as specified in Paragraph D.

D. Network user interface and value passing shall be transparent to network architecture.

1. A user interface connected to the BAS shall allow the user to interface with networked controllers as if directly connected. BAS information such as data, status, reports, system software, and custom programs, shall be viewable and editable from the user interface.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be available on the network. Program and test all cross-controller links required to execute specified BAS operation. An authorized user shall be able to manage, maintain, and access the BAS network of controllers.

E. Workstations, Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clock daily from an user designated device via the network. The system shall automatically adjust for daylight saving and standard time as applicable.

F. System shall be expandable to at least twice the required data points with additional controllers, associated devices, and wiring. Expansion shall not require user interface hardware additions or software revisions.

G. BACnet Router. BACnet routers shall, at a minimum, implement the device requirements as specified as follows.

1. A device that conforms to the BACnet protocol and contains an application layer shall:

a. contain exactly one Device object,

b. execute the ReadProperty service,

c. execute the Who-Has and Who-Is services (and thus initiate the I-Have and I-Am services) unless the device is an MS/TP slave device,

d. execute the WriteProperty service if the device executes the WritePropertyMultiple, AddListElement or RemoveListElement services,

e. allow the WriteProperty service to modify any properties that are modifiable by the AddListElement or RemoveListElement services,

f. execute the WriteProperty service if the device contains any objects with properties that are required to be writable,

g. have a configurable device instance that can take on any value across the range 0 .. 4194302, and

h. contain a Network Port object for each configured network port.

2.3 Enterprise Network Server

A. The Enterprise Network Server shall support all Embedded Controller/Web Servers connected to the owner's network whether local or remote.

B. The Enterprise Network Server Software shall provide the following functions, at a minimum:

1. Global Data Access: The Enterprise Network Server shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The Enterprise Network Server shall provide the ability to execute global control strategies based on control and data objects in any Embedded Controller/Web Server in the network, local or remote.
3. The Enterprise Network Server shall include a master clock service for its subsystems and provide time synchronization for all Embedded Controller/Web Servers.
4. The Enterprise Network Server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
5. The Enterprise Network Server shall provide scheduling for all Embedded Controller/Web Servers and their underlying field control devices.
6. The Enterprise Network Server shall provide demand limiting that operates across all Embedded Controller/Web Servers. The Enterprise Network Server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
7. The Enterprise Network Server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Embedded Controller/Web Servers. Systems not employing this prioritization shall not be accepted.
8. Each Embedded Controller/Web Server supported by the Enterprise Network Server shall have the ability to archive its log data, alarm data and database to the Enterprise Network Server, automatically. Archiving options shall be user-defined including archive time and archive frequency. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. The server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2 and HTTP/HTML/XML, CSV or text formats. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
9. The Enterprise Network Server shall provide central alarm management for all Embedded Controller/Web Servers supported by the Enterprise Network Server. Alarm management shall include:
    a. Routing of alarms to display, email, and pagers
    b. View and acknowledge alarms
    c. Query alarm logs based on user-defined parameters
10. The Enterprise Network Server shall provide central management of log data for all Embedded Controller/Web Servers supported by the Enterprise Network Server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
    a. Viewing and printing log data
    b. Exporting log data to other software applications
    c. Query log data based on user-defined parameters

C. The Enterprise Network Server hardware platform shall have the following minimum requirements:

1. Processor: Intel Xeon x64 (or better), compatible with dual- and quad-core processors
2. Operating System: Windows 10, 64-bit Windows 8.1 Enterprise, Windows Server 2012 R2 Standard, RHEL-7
3. Memory: 8 GB
4. Hard Drive: 1 TB
5. Display: Video card capable of displaying 1024 x 768 pixel resolution or greater
6. Network Support: NIC card rated for at least 1 Gigabit or 10 Gigabit Ethernet

2.4 Embedded Controller/Web Server (EC/WS)

A. Embedded Controller/Web Server(s) shall manage communications between the BACnet Advanced Application Controllers (B-AAC), BACnet Advanced VAV Controller (B-AVAVC), BACnet Application Specific Controllers (B-ASC), and Mechanical Equipment Controllers (MEC) which are connected to its communications trunks, manage communications between itself and other Embedded Controller/Web Servers and with Enterprise Network Server that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS. All hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted “safe boot” technology.

B. The communication protocols utilized for peer-to-peer communications between Embedded Controller/Web Servers and with Enterprise Network Server will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between Embedded Controller/Web Servers is not allowed.

C. The EC/WS shall employ a device count capacity license model that supports expansion capabilities.

D. The EC/WS shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:

1. BACnet
2. Lon
3. MODBUS
4. SNMP
5. KNX

E. The EC/WS shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of LonWorks, BACnet, and MODBUS controller data
7. Network management functions for all EC/WS, B-AAC, B-AVAVC, and B-ASC devices.

F. The EC/WS shall provide the following hardware features as a minimum:

1. Two 10/100 Mbps Ethernet ports
2. Two Isolated EIA-485 ports with biasing switches
3. 1 GB RAM
4. 4 GB Flash Total Storage / 2 GB User Storage

5. Wi-Fi (Client or WAP)
6. USB Flash Drive
7. High-Speed Field Bus Expansion
8. -20 to 60 degree C Ambient Operating Temperature
9. Integrated 24 VAC/DC Global Power Supply
10. MicroSD Memory Card employing Encrypted Safe Boot Technology

G. The EC/WS shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

H. The EC/WS shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.

I. The EC/WS shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.

1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
   a. Alarm
   b. Return to normal
   c. To default

2. Alarms shall be annunciated in any of the following manners as defined by the user:
   a. Screen message text
   b. Email of complete alarm message to multiple recipients
   c. Pagers via paging services that initiate a page on receipt of email message
   d. Graphics with flashing alarm object(s)

3. The following shall be recorded by the SNC for each alarm (at a minimum):
   a. Time and date
   b. Equipment (air handler #, access way, etc.)
   c. Acknowledge time, date, and user who issued acknowledgement

J. Programming software and all controller "Setup Wizards" shall be embedded into the EC/WS.

K. The EC/WS shall support the following security functions:

1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted
2. Role-Based Access Control (RBAC) for managing user roles and permissions
3. Require users to use strong credentials
4. Data in Motion and Sensitive Data at Rest be encrypted
5. LDAP and Kerberos integration of access management

L. The EC/WS shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:

1. Metadata: Descriptive tags to define the structure of properties
2. Tagging: Process to apply metadata to components
3. Tag Dictionary

M. The EC/WS shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer’s controller and relationships. All lower level communicating controllers (B-

AAC, B-AVAVC, B-ASC, VFD…) shall have an associated template file for reuse on future project additions.

N. The EC/WS shall be provided with a 5 Year Software Maintenance license. Labor to implement not included.

2.5 Graphical User Interface

A. All Embedded Controller/Web Servers shall be accessed via a single connection to the Enterprise Network Server. In this configuration, each Embedded Controller/Web Server can be accessed from a PC using Thin-Client Remote Desktop Connection User Interface and/or a PC using Thin-Client Web Browser User Interface.

B. The Thin-Client Remote Desktop Connection User Interface shall use any of the current versions of Windows Server with Remote Desktop Services and shall allow the Enterprise Server to host multiple, simultaneous client sessions. Remote Desktop shall use Remote Desktop Services technology to allow a single session to run remotely. A user shall connect to a Remote Desktop Session Host (RD Session Host) server by using Remote Desktop Connection (RDC) client software. Thin-client hardware devices running an embedded Windows-based operating system shall run the RDC client software to connect to the RD Session Host Enterprise Server.

C. The Thin-Client Web Browser User Interface shall use any of the current versions of Microsoft Internet Explorer, Microsoft Edge, Mozilla Firefox, or Google Chrome browsers from any computer. The thin-client web browser shall be operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary user interface and configuration programs or browser plug-ins. Communication between the Thin-Client Web Browser User Interface and the Enterprise Network Server shall offer, at a minimum, encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

D. Software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote connected user interfaces.

F. The user interface shall be completely interactive and shall provide a HTML5 experience that supports the following features as a minimum:

1. Trending.
2. Scheduling.
3. Electrical demand limiting.
4. Duty Cycling.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.

8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of users.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

G. Software Components: All software shall be the most current version. All software components of the BAS software shall be provided and installed as part of this project. BAS software components shall include:

1. Server Software, Database and Graphical User Interface.
2. 5 Year Software Maintenance Agreement. Labor to implement shall be included.
3. Embedded System Configuration Utilities for future modifications to the system and controllers.
4. Embedded Graphical Programming Tools.
5. Embedded Direct Digital Control software.
6. Embedded Application Software.
7. Embedded Native Function-block programming software and all controller “Setup Wizards”.

H. Login: On launching the user interface and selecting the appropriate domain name or IP address, the user shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the user's role-based application control privileges.

I. Web Page Navigation: Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven user interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for user access, reports and reporting actions for events.

J. Tree Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the user to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.

1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View shall display Scheduled Groups and custom reports.
3. Configuration View shall display all the configuration categories (Users, Schedule, Event, Reporting and Roles).

K. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.

2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web-browser. User shall have ability to save custom dashboards.
3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the user to depress an 'accept/cancel' button.
5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
8. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

L. Color Graphics: The GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI user interface software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. .
5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
    a. Each piece of equipment monitored or controlled including each terminal unit.
    b. Each building.
    c. Each floor and zone controlled.

M. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the GUI, a user (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further user intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
   a. Types of schedule shall be Normal, Holiday or Override.
   b. A specific date.
   c. A range of dates.
   d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
   e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow users to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, users shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the user shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the user schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the user (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

N. Alarms:

1. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
2. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
3. Alarm Reactions. The operator shall be able to determine (by object) what, if any, actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.
4. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
5. Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
   a. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a

bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An user shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.

b. Alarm Categories: The user shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the user to easily sort through multiple events displayed.

c. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.

d. Alarm Areas: Alarm Areas enable an user to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an user to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.

e. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.

f. Alarm Configuration: Users shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.

g. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.

h. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an user defined period.

i. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Users shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
    1) Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
    2) Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
    3) File Write: The ASCII File write reporting action shall enable the user to append user defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the user. The user may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
    4) Write Property: The write property reporting action updates a property value in a hardware module.
    5) SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
    6) Run External Program: The Run External Program reporting action launches specified program in response to an event.

j. There shall be 4 levels of alarm
    1) Level 1: Life-safety message
    2) Level 2: Critical equipment message

3) Level 3: Urgent message
4) Level 4: Normal message

k. Maintenance Mode. Operators shall have the ability to put any device in/out of maintenance mode.
1) All 1) All alarms associated with a device in maintenance mode will be suppressed except life safety alarms.
2) If a device is in maintenance mode, issue a daily Level 3 alarm at a scheduled time indicating that the device is still in maintenance mode.

l. Entry Delays. All alarms shall have an adjustable delay time such that the alarm is not triggered unless the alarm condition is TRUE for the delay time. Default entry delays are as follows:
1) Level 1 alarms: 1 seconds
2) Level 2 alarms: 10 seconds
3) Level 3 alarms: 1 minutes
4) Level 4 alarms: 5 minutes

m. Exit Hysteresis
1) Each alarm shall have an adjustable time-based hysteresis (default: 5 seconds) to exit the alarm. Once set, the alarm does not return to normal until the alarm conditions have ceased for the duration of the hysteresis.
2) Each analog alarm shall have an adjustable percent-of-limit-based hysteresis (default: 0% of the alarm threshold, i.e., no hysteresis; alarm exits at the same value as the alarm threshold) the alarmed variable required to exit the alarm. Alarm conditions have ceased when the alarmed variable is below the triggering threshold by the amount of the hysteresis.

n. Latching. Any alarm can be configured as latching or nonlatching. A latching alarm requires acknowledgment from the operators before it can return to normal, even if the exit deadband has been met. A nonlatching alarm does not require acknowledgment. Default latching status is as follows:
1) Level 1 alarms: latching
2) Level 2 alarms: latching
3) Level 3 alarms: nonlatching
4) Level 4 alarms: nonlatching

o. Postexist. Suppression Period. To limit alarms, any alarm may have an adjustable suppression period such that, if the alarm is triggered, its postsuppression timer is triggered and the alarm may not trigger again until the postsuppression timer has expired. Default suppression periods are as follows:
1) Level 1 alarms: 0 minutes
2) Level 2 alarms: 5 minutes
3) Level 3 alarms: 24 hours
4) Level 4 alarms: 7 days

p. For both latching and nonlatching alarms, the operators may acknowledge the alarm. Acknowledging an alarm clears the alarm, the exit deadband, and suppression period. A device can go right back into alarm as soon as the entry delay elapses.

O. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The user shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.

2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at user-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The user shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
8. Group Trend Time Series Plots
    a. Provide user-selectable Y points.
    b. Provide user-editable titles, point names, and Y axis titles.
    c. Individual trended points shall be able to be grouped in groups of up to four points per plot with up to four plots per page.
9. X-Y Trend Plots
    a. User- selectable X and Y trend inputs.
    b. User- editable titles, point names, and X and Y axis titles.
    c. User- selectable time period options:
        1) A 1-day 24-hour period;
        2) A 1-week 7-day period;
        3) A 1-month period, with appropriate days for the month selected; or (4) a 1-year period.
        4) The user shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.
    d. User- selectable display of up to 6 plots per screen in 2 columns.

P. Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the Enterprise Server hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.

Q. Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

R. Building Metrics Reports

1. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each building meter.
2. Provide an annual (12-month) summary report showing the monthly electrical consumption and peak demand with time and date stamp for each meter.

3. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12- month) report that shows the monthly consumption for each meter.
4. Weather Data Report: Provide a monthly report showing the daily minimum, maximum, and average outdoor air temperature, as well as the number of heating and cooling degree-days for each day. Provide an annual (12-month) report showing the minimum, maximum, and average outdoor air temperature for the month, as well as the number of heating and cooling degree-days for the month.
5. Energy Calculations: Provide software to allow instantaneous power (e.g., kW) or flow rates (e.g., L/s [GPM]) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window average (e.g., rolling average). The algorithm shall be flexible to allow window intervals to be user specified (e.g., 15-minutes, 30-minutes, 60-minutes). Provide an algorithm that calculates a fixed-window average. A digital input signal shall define the start of the window period (e.g., signal from utility meter) to synchronize the fixed window average with that used by the utility.
6. Provide the following building performance metrics in dynamic graphical and tabular formats at the graphical user interface. Submit calculations to Engineer of all calculated variables for approval. Continuously monitor dynamic data measurements and calculated data variables and automatically archive data to real-time data storage at fifteen-minute intervals. Provide real-time data storage capacity for 18 months and off-line data storage capacity for 5 years. Every 12 months automatically transfer real-time data storage to off-line data storage.
    a. Temperature Summary
        1) Average Indoor Air Temperature (^{o}F)
        2) Average Indoor Air Temperature Setpoint (^{o}F)
        3) Lowest Indoor Air Temperature (^{o}F)
        4) Lowest Indoor Air Temperature Setpoint (^{o}F)
        5) Highest Indoor Air Temperature (^{o}F)
        6) Highest Indoor Air Temperature Setpoint (^{o}F)
        7) Current Outdoor Air Temperature (^{o}F)
        8) Current Outdoor Heat Index (HI)
        9) Forecasted High Outdoor Air Temperature (^{o}F)
        10) Forecasted Low Outdoor Air Temperature (^{o}F)
        11) Forecasted Heating Degree Days
        12) Forecasted Cooling Degree Days
        13) 30-year Daily Average Heating Degree Days
        14) 30-year Daily Average Cooling Degree Days
    b. Electricity Summary
        1) Current Electricity Usage (kWh)
        2) Target Electricity Usage (kWh)
        3) Predicted Electricity Usage (kWh)
        4) Month to Date Electricity Usage (kWh)
        5) Year to Date Electricity Usage (kWh)
        6) Current Electricity Site Energy (kBtu)
        7) Target Electricity Site Energy (kBtu)
        8) Predicted Electricity Site Energy (kBtu)
        9) Month to Date Electricity Site Energy (kBtu)
        10) Year to Date Electricity Usage Site Energy (kBtu)
        11) Current Electricity Source Energy (kBtu)
        12) Target Electricity Source Energy (kBtu)
        13) Predicted Electricity Source Energy (kBtu)
        14) Month to Date Electricity Source Energy (kBtu)
        15) Year to Date Electricity Usage Source Energy (kBtu)
    c. Gas Summary
        1) Current Gas Usage (therms)

2) Predicted Gas Usage (therms)
3) Month to Date Gas Usage (therms)
4) Year to Date Gas Usage (therms)
5) Current Gas Site Energy (kBtu)
6) Target Gas Site Energy (kBtu)
7) Predicted Gas Site Energy (kBtu)
8) Month to Date Gas Site Energy (kBtu)
9) Year to Date Gas Usage Site Energy (kBtu)
10) Current Gas Source Energy (kBtu)
11) Target Gas Source Energy (kBtu)
12) Predicted Gas Source Energy (kBtu)
13) Month to Date Gas Source Energy (kBtu)
14) Year to Date Gas Usage Source Energy (kBtu)

d. Energy Intensity Summary
1) Electricity Site Energy Intensity (kBtu/ft^2-yr)
2) Gas Site Energy Intensity (kBtu/ft^2-yr)
3) Electricity Source Energy Intensity (kBtu/ft^2-yr)
4) Gas Source Energy Intensity (kBtu/ft^2-yr)
5) Combined Total Energy Intensity (kBtu/ft^2-yr)
6) Target Combined Total Energy Intensity (kBtu/ft^2-yr)
7) Predicted Combined Total Energy Intensity (kBtu/ft^2-yr)
8) Energy Cost Intensity ($/$ft^2$)

e. Green House Gas (GHG) Emission Summary
1) Current Direct GHG Emissions ($MtCO_2e$)
2) Current Indirect GHG Emissions ($MtCO_2e$)
3) Current Total GHG Emissions ($MtCO_2e$)
4) Target Total GHG Emissions ($MtCO_2e$)
5) Predicted Total GHG Emissions ($MtCO_2e$)

f. Water Summary
1) Indoor Water Use (kGal)
2) Indoor Water use per sq. ft. (kGal)
3) Outdoor Water Use (kGal)
4) Total Indoor and Outdoor Water Use (kGal)
5) Wastewater/Sewer Use (kGal)

S. Security Access: Systems that access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:

1. Roles: Roles shall reflect the actual roles of different types of users. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
   a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Users, Roles and Privileges, Alarm/Event Template and Reporting Action.
   b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
   c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.

T. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same user defined HVAC Role) to different areas of the system.

U. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

V. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

W. Graphic Sequence: The clarity of the graphic sequence shall be such that the user has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the user with an understandable and exact representation of each sequence of operation.

X. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:

1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.

Y. Live Graphical Programs: The Graphic Programming software shall support a ' live' mode, where all input/output data, calculated data and set points shall be displayed in a ' live' real-time mode.

2.6 BACnet Advanced Application Controller (B-AAC)

A. General. Provide an adequate number of BACnet Advanced Application Controllers (B-AAC) to achieve the performance specified in the Part 1 Article on “System Performance”. B-AAC shall provide microprocessor based self-contained stand-alone fully programmable operation of local process control loops. The controller platform shall provide options and advanced system functions, programmable and configurable, that allow standard and customizable control solutions required in executing the "Sequence of Operation". All local level application programs shall be installed on individual controllers in non-volatile memory. Control systems that utilize ‘canned’ programs or programmable read only memory (PROM) level application programming are not acceptable. Each of these panels shall meet the following requirements.

1. The B-AAC shall have sufficient memory to support its operating system, database, and programming requirements.
2. Data shall be shared between networked B-AACs.
3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
4. Controllers that perform scheduling shall have a real-time clock.
5. The B-AAC shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall
    a. Assume a predetermined failure mode,
    b. Generate an alarm notification.
6. The B-AAC shall communicate with other BACnet devices on the network using protocol specific services.
7. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
8. Provide documentation for each device, with the following information:
    a. BACnet Device; MAC address, name, type and instance number,
    b. BACnet Objects; name, type and instance number.

B. Communication

1. Each B-AAC shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
2. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator’s terminal.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator’s terminal.

E. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

F. Memory. The B-AAC shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

G. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

H. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.

2.7 BACnet Application Specific Controller (B-ASC)

A. General. BACnet Application Specific Controllers (B-ASCs) are microprocessor-based BAS controllers which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable, but are customized for operation within the confines of the equipment they are designed to serve. B-ASCs may not be used for complex sequences of operation. B-ASCs shall communicate with other BACnet devices on the network using the Read (Execute) Property service as defined in Clause 15.5 of ASHRAE Standard 135. Each B-ASCs shall be certified or listed for compliance to the BACnet standards.

1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network
2. Each B-ASC will contain sufficient I/O capacity to control the target system.
3. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
4. Provide documentation for each device, with the following information:
    a. BACnet Device; MAC address, name, type and instance number,
    b. BACnet Objects; name, type and instance number.

B. Communication

1. Each controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol. Each network of controllers shall be connected to one building controller.
2. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable user’s tool. This connection shall be extended to a space temperature sensor port where shown and allow access to the entire network.
3. Each controller shall have a secondary sub network for communicating sensors or I/O expansion modules.

C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32 degrees F to 150 degrees F and 10 to 90 percent RH.
2. Controllers used in conditioned space shall be mounted in dust proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F.

D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

E. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.

F. Immunity to power and noise. Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

G. Transformer. Power supply for the ASC must be rated at a minimum of 125 percent of ASC power consumption and shall be of the fused or current limiting type.

H. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.

2.8 MODBUS System Integration

A. The BAS shall support the integration of device data from MODBUS RTU, ACSII, or TCP control system devices. The connection to the MODBUS system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

1. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the MODBUS system data into the FPMS. Objects provided shall include at a minimum:
2. Read/Write MODBUS AI Registers
3. Read/Write MODBUS AO Registers
4. Read/Write MODBUS BI Registers
5. Read/Write MODBUS BO Registers

B. All scheduling, alarming, logging and global supervisory control functions, of the MODBUS system devices, shall be performed by the Network Area Controller.

C. The BAS supplier shall provide a MODBUS system communications driver. The equipment system vendor that provided the equipment utilizing MODBUS shall provide documentation of the system's MODBUS interface and shall provide factory support at no charge during system commissioning.

2.9 Input/Output Interface

A. Hardwired inputs and outputs may tie into the BAS through building, advanced application, or application specific controllers.

B. All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground, shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 volts of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low-voltage (0-10 VDC), current (4-20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with – and field configurable to – commonly available sensing devices.

F. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and advanced application controllers shall have three-position (On/Off/Auto) override switches, and status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC signal or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or advanced application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4 percent of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation, etc.) Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of user tracking.

I. Input/Output points shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

J. System Capacity. The system size shall be expandable to at least twice the number of input/output objects/points required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The user interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

K. Each controlled device or function shall be a separate output of the digital controller (i.e., Economizer, Heating Valve, Cooling Valve are three (3) separate output points). When a points' list is provided the greater number of points and their configuration shall govern. Multiplexers or programmable logic controllers utilized with digital controller input and output points to expend the digital controller I/O capabilities will not be allowed.

PART 3 - EXECUTION

3.1 Pre-Installation Sequences of Operations Meeting

A. Prior to shop drawings submittals and any hardware installation, set-up and conduct a “Sequences of Operations” meeting to review the specified sequences to confirm an understanding of intent. Invited attendees shall include the BAS software programming technicians, Owner’s representative(s), Commissioning agent, Construction Manager, and Engineer of Record. Coordinate with Construction Manager.

3.2 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor's work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the temperature control work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect to report such discrepancies shall be made by and the costs borne by this Contractor.

3.3 Protection

A. Protect all work and material from damage by their work or employees, and shall be liable for all damage thus caused.

B. The installing contractor shall be responsible for their work and equipment until finally inspected, tested, and accepted. Protect any material that is not immediately installed. Close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 Coordination

A. Site

1. Where the temperature control work will be installed in close proximity to, or will interfere with work of other trades, assist in working out space conditions to make a satisfactory adjustment. If temperature control work is installed before coordinating with other trades, so as to cause any interference with work of other trades, the temperature control work shall be re-worked to correct the condition without extra charge.
2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.

B. Test and Balance

1. Furnish all tools necessary to interface to the control system for test and balance purposes.
2. Provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
3. In addition provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.

C. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated as follows:

1. All communication media and equipment shall be provided as specified in Part 2: "Communication" of this specification.
2. Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
3. Coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.

D. Revise equipment tagging and nomenclature, room numbering, etc. to reflect as-built conditions or an Owner's preference for integration into their existing naming numbering convention.

3.5 Field Quality Control

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.

B. Continually monitor the field installation for code compliance and quality of workmanship.

C. Have work inspected by authorities having jurisdiction over the work.

3.6 Controllers

A. Provide a separate controller for each AHU, terminal unit, fan coil, and other unitary equipment and HVAC systems. A DDC controller may control more than one system provided that all points/objects associated with the system are assigned to the same DDC controller. Points/objects used for control loop reset such as outside air or space temperature are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15 percent spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15 percent of each type is required. If outputs are not universal, 15 percent of each type is required. A minimum of one spare is required for each type of point/object used.

1. Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points.

3.7 Programming

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25 percent of available memory free for future use.

B. Point/object Naming: System point/object names shall be modular in design, allowing easy user interface without the use of a written point/object index. Use the following naming convention:
AAABBBCCCDDDEEE where:

AAA is used to designate the location of the point/object within the building such as mechanical room, wing, or level, or the building itself in a multi-building environment.

BBB is used to designate the mechanical system with which the point/object is associated (e.g., A01, HTG, CLG, LTG).

CCC represents the equipment or material referenced (e.g., SAF for supply air fan, EXF for exhaust fan, RAF for return air fan).

D or DD or DDD may be used for clarification or for identification if more than one of CCC exists (e.g., SAF10, EXF121).

EE represents the action or state of the equipment or medium (e.g., T for temperature, RH for humidity, CO for control, S for status, D for damper control, I for current).

C. Software Programming

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
   a. Text-based:
      1) must provide actions for all possible situations
      2) must be modular and structured
      3) must be commented
   b. Graphic-based
      1) must provide actions for all possible situations
      2) must be documented
   c. Parameter-based
      1) must provide actions for all possible situations
      2) must be documented
2. After submittal and review of control software, offer to schedule a meeting with the Engineer and Commissioning Agent (CxA) to review system function.

D. Graphical User Interface

1. Standard Graphics. Provide graphics for all controlled systems and floor plans of the building. Point/object information on the graphic displays shall dynamically update. Show on each graphic all input and output points/objects for the system. Also show relevant calculated points/objects such as setpoints.
2. Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point/object show.
3. Provide all the labor necessary to install, initialize, start up, and troubleshoot all user interface software and their functions as described in this section. This includes any operating system software, the user interface database, and any third-party software installation and integration required for successful operation of the user interface.
4. Provide graphic representation of each system. Graphic shall have a link to its respective approved as-built sequence of operation in portable document format (pdf) or hypertext markup language format (html).
5. Provide graphic representation of each control device component (sensor, controller, controlled device). Each control device component graphic representation shall have a cursor-hover-over pull-down box with links to the manufacturer’s data sheet, installation instructions, maintenance instructions, and programming instructions literature in portable document format (pdf) or hypertext markup language format (html). Also, provide a link to an active trend of sensor and controlled device components.

6. Provide graphic representation of each equipment component (pump, boiler, chiller, air handling unit, etc.). Each equipment component shall have a cursor-hover-over pull-down box with links to the manufacturer's data sheet, installation, maintenance, and programming literature in portable document format (pdf) or hypertext markup language format (html). For equipment components with factory mounted controllers provide an additional link to a graphic representation of all equipment controller data available via the respective communication protocol interface in tabular format.
7. The BAS Contractor shall initially prepare and be responsible for a Graphical User Interface Development Plan. The plan shall describe the process for the development of the GUI.
8. GUI Scope Meeting: Within 45 days from execution of the Contract, participate in a scope meeting with the GUI Development Team chaired by the BAS Contractor. The purpose of the meeting includes a review of the GUI Development Plan with discussions of development schedule, graphical requirements, and assignments of responsibilities.
9. GUI Coordination Meetings: The GUI Development Team members will meet on a predetermined and approved basis (by the Owner) to review progress on the GUI work, coordinate scheduling conflicts, and to discuss strategies and processes for upcoming tasks. The meetings will be chaired by the BAS Contractor. Allow for 80 hours of meeting time.
10. GUI Development Meeting Minutes: The BAS Contractor shall prepare minutes of the initial scope and progress meetings, and shall include a copy of the agenda, and identify location and date of the meeting, and individuals in attendance. Minutes shall be distributed to members of the GUI Development Team.
11. GUI Development Team: Members of the GUI Development Team shall include, but not be limited to the Owner, BAS Contractor, and such parties designated by the Owner or BAS Contractor.

3.8 Control System Checkout and Testing

A. Start-up Testing: All testing listed in this article shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner's Representative is notified of the system demonstration.

1. Upon completion of the control system, adjust all components of the system. Make all adjustments in the control system required and as directed by the balancer to achieve the desired air balance quantities. All instruments shall be carefully calibrated and each control function shall be demonstrated to function properly, to the satisfaction of the Engineer and the Owner. Provide a complete instruction manual covering the function and operation of all components. At the time of demonstration, each function shall be simulated to ensure that controls respond properly to all signals, and the Owner shall be instructed in the proper operation of the system.
2. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
3. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
4. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations.
5. Verify that all binary output devices (relays, solenoid valves, two position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
6. Verify that all analog output devices (transducers, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. Check all control valves and automatic dampers to ensure proper action and closure. Make any necessary adjustments to valve stem and damper blade travel.

7. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
8. Alarms and Interlocks
   a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
   b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
   c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
9. Each unit and associated controls, safeties and wiring shall be checked out, started and adjusted by a factory trained service technician. Submit a startup report including a list of all unit safety and control settings, whether fixed or adjustable, as field checked and setup per the specified design conditions five days after unit startup. Submit service technician certification upon request.

3.9 Control System Demonstration and Acceptance

A. Demonstration

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the temperature controls have been completed, started up and performed its own tests.
2. The tests described in this section are to be performed in addition to the tests that are performed as a necessary part of the installation, startup, and debugging process and as specified in the “Control System Checkout and Testing” Article in Part 3 of this specification. The Engineer may be present to observe and review these tests. The Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1: “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. Provide at least two persons equipped with two way communication, and demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point/object and system. Provide and operate any test equipment required to prove the proper operation.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1: “System Performance.
7. Demonstrate compliance with Sequences of Operation through all modes of operation.
8. Demonstrate complete operation of User Interface.
9. Additionally, the following items shall be demonstrated:
   a. Optimum Start. Supply a trend data output showing the capability of the algorithm. The hour by hour trends shall include the output status of all optimally started equipment, as well as temperature sensor inputs of affected areas.
   b. Interface to the building fire alarm system.
   c. Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Engineer. These logs shall cover three 48 hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date, and any necessary repairs or revisions to the hardware or software to successfully complete all tests shall be made.

B. Acceptance

1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: Submittals.

C. During the first year of operation, after acceptance by the Owner, provide complete service to adjust or assist the Owner in adjusting the equipment to obtain optimum performance from the control equipment and from the heating and air conditioning systems in general. This shall be done without additional expense to the Owner. This work shall include revisions to DDC software programs and controller, and all PC front end software upgrades. All software shall be provided to the Owner in disk form, including back-ups of final field programs.

3.10 Cleaning

A. Clean up all debris resulting from its activities daily. Remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.11 Training

A. Provide a minimum of three onsite training classes 8 hours in length during the construction period for personnel designated by the owner.

B. Provide two additional training sessions at 6 and 12 months following building's turnover. Each session shall be 8 hrs. in length and must be coordinated with the building Owner.

C. Train the designated staff of Owner's Representative and Owner to enable them to:

1. Day-to-day Users:
   a. Proficiently operate the system
   b. Understand control system architecture and configuration
   c. Understand DDC system components
   d. Understand system operation, including DDC system control and optimizing routines (algorithms)
   e. Operate the user interface and peripherals
   f. Log on and off the system
   g. Access graphics, point/object reports, and logs
   h. Adjust and change system setpoints, time schedules, and holiday schedules
   i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
   j. Understand system drawings, and Operation and Maintenance manual

k. Understand the job layout and location of control components
l. Access data from DDC controllers
m. Operate portable operator's terminals

2. Advanced Users:
   a. Make and change graphics on the user interface
   b. Create, delete, and modify alarms, including annunciation and routing of these
   c. Create, delete, and modify point/object trend logs, and graph or print these
   d. Create, delete, and modify reports
   e. Add, remove, and modify system's physical points/objects
   f. Create, modify, and delete programming
   g. Add panels when required
   h. Add user interface stations
   i. Create, delete, and modify system displays — both graphical and otherwise
   j. Perform BAS system field checkout procedures
   k. Perform DDC controller unit operation and maintenance procedures
   l. Perform user interface and peripheral operation and maintenance procedures
   m. Perform BAS system diagnostic procedures
   n. Configure hardware including PC boards, switches, communication, and I/O points/objects
   o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
   p. Adjust, calibrate, and replace system components
3. System Managers/Administrators:
   a. Maintain software and prepare backups
   b. Interface with job-specific, third-party user software
   c. Add new users and understand password security procedures

D. Provide course outline and materials as per "Submittals" Article in Part 1 of this specification. The instructor(s) shall provide one copy of training material per student.

E. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

F. Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.12 Outdoor temperature and humidity sensors shall be mounted on the north face of the building unless otherwise approved by the Engineer. Exact location shall be approved by the Architect.

3.13 In addition to the adjustments and fine tuning, include as a part of this contract the equivalent of five (5) man days of service technician and/or programming time for work as may be specified by the Engineer.

END OF SECTION

23 09 25 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 This section describes all sensors, controllers, instruments, valves, actuators, devices, for use with the control system specified in Section 23 09 23 Building Automation System (BAS) for HVAC. All control devices (valves, dampers, actuators, etc.) shall be included.

1.2 Refer to the HVAC Drawings, Section 23 09 23 Building Automation System (BAS) for HVAC, Section 23 09 93 Sequences of Operations, Section 23 09 95 BAS Points List, for sensor and device requirements.

1.3 All products used in the installation shall be new, currently under manufacture, and shall be applied in standard off the shelf products. This installation shall not be used as a test site for any new products unless explicitly approved by the Engineer in writing. Spare parts shall be available for at least 10 years after completion of this contract.

1.4 System shall conform to the following minimum standards over network connections:

A. Reporting Accuracy. System shall report values with the minimum end-to-end accuracy listed in Table 1.

B. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

TABLE 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5ºC [±1ºF]
Ducted Air	±0.5ºC [±1ºF]
Outside Air	±1.0ºC [±2ºF]
Dewpoint	±1.5ºC [±3ºF] (-76 to 176°F scale)
Water Temperature	±0.5ºC [±1ºF]
Delta-T	±0.15ºC [±0.25ºF]
Relative Humidity	±5% RH (0 – 90% scale)
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized space)	±3% of full scale
Air Pressure (ducts)	±25 Pa [±0.1" w.g.]
Air Pressure (space)	±3 Pa [±0.01" w.g.]
Electrical (A, V, W, Power factor)	±1% of reading
(see Note 3)	
Carbon Monoxide / Nitrogen Dioxide (NO2)	±5% of reading
Carbon Dioxide (CO2)	±50 ppm

Notes:
(1) Accuracy applies to 10 percent - 100 percent of scale.
(2) For both absolute and differential pressure.
(3) Not including utility supplied meters.

TABLE 2: Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa [±0.2" w.g.]	0-1.5 kPa [0-6" w.g.]
	±3 Pa [±0.01" w.g.]	-25 to 25 Pa [-0.1 to 0.1" w.g.]
Airflow	±10% of full scale	
Space Temperature	±1.0ºC [±2.0ºF]	
Duct Temperature	±1.5ºC [±3.0ºF]	
Humidity	±5% RH	
Differential Enthalpy	±5 kJ/kg [±3 Btu/lb]	35 – 63 kJ/kg [20-36 Btu/lb]

PART 2 - PRODUCTS

2.1 Actuators And Operators

A. Electronic Actuators

1. Actuators shall include electronics to receive the digital controllers analog position signal and maintain the position through the use of positive position feedback. Torque of the actuator shall be the working pressures of the system for valves, the total static differential of an air system, plus 30 percent safety factors. Actuator shall be UL or other approved testing agency listed. Actuators shall be manufactured by Belimo Air Controls or approved equal.
2. Electronic actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
3. Unless noted otherwise as “floating point control”, mechanical fail safe shall incorporate a spring-return mechanism to return to the device to its “normal” position on loss of power. Electronic fail safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors with a visual indication of the fail safe status on the actuator face with the power fail position field adjustable between 0 to 100 percent in 10 degree increments, an adjustable 0 – 10 second operational delay, and capable of changing the fail-safe position through an integrated switch without removing the mounted actuator.
4. All rotary spring-return actuators shall be capable of both clockwise and counter-clockwise spring-return operation. Linear actuators shall spring-return to the retracted position.
5. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
6. All 24 VAC/VDC actuators shall operate on Class 2 wiring and shall not require more than 10 VA for AC or more than 8 W for DC applications. Actuators operating on 120 VAC or 230 VAC shall not require more than 11 VA.

7. All actuators shall have an external manual gear release to allow manual positioning of the device when the actuator is not powered. Spring-return actuators with more than 7 N•m [60 in-lb] torque capacity shall have a manual crank for this purpose.
8. Actuators shall be provided with a raceway fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
9. Actuators shall be designed for a minimum of 60,000 full-stroke cycles at the actuator's rated torque.

2.2 Sensors And Transmitters

A. Any temperature or humidity sensing device mounted on an exterior wall shall be fitted with an insulated sub-base.

B. Binary Temperature Devices

1. Low-voltage space thermostats shall be 24 V, bimetal-operated type, concealed setpoint adjustment, 55 degrees F to 85 degrees F setpoint range, 2 degrees F maximum differential, and vented ABS plastic cover. Provide subbase with manual or automatic switching as required to perform the specified functions. Thermostats shall be single or multi-stage or modulating output as required to perform the functions specified.
2. Line-voltage space thermostats shall be bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, UL listed for electrical rating, concealed setpoint adjustment, 55 degrees F to 85 degrees F setpoint range, 2 degrees F maximum differential, and vented ABS plastic cover. Provide subbase with manual or automatic switching as required to perform the specified functions. Thermostats shall be single or multi-stage or modulating output as required to perform the functions specified.
3. Low-limit thermostats (freezestats). Low-limit airstream thermostats shall be UL listed, vapor pressure type or electronic type, with an element 20 ft. minimum length. Element shall cover the face of the coil at 1 ft. centers in a horizontal serpentine fashion and shall respond to the lowest temperature sensed by any 1 ft. section. When one freezestat cannot meet this requirement provide multiple freezestats. Unless noted otherwise, low-limit thermostats shall be manual reset type. Freezestats shall be supplied as DPST with one (1) set of normally closed contacts wired directly to fan circuit and one (1) set of normally open contacts to provide an alarm to the BAS.

C. Temperature Sensors
1. Temperature sensors shall be thermistors and be suitable for the application. Where feasible, provide the same sensor type throughout the project. Avoid using transmitters unless absolutely necessary. Sensor accuracy over the application range shall be 0.36 degree F or less between 32 to 150 degrees F. Stability error of the thermistor over five years shall not exceed 0.25 degree F cumulative. A/D conversion resolution error shall be kept to 0.1 degree F. Total error for a thermistor circuit shall not exceed 0.5 degree F.
2. Duct sensors shall be single point or averaging as shown or specified. Averaging sensors shall be a minimum of 5 feet in length per 10 sq. ft. of duct cross section. Mixed air and discharge air sensors shall be averaging type.
3. Space sensors shall be equipped with setpoint adjustment, occupancy mode override switch, display, and communication port. Thermostat cover shall be rectangular high impact ABS plastic (or equal) in a neutral cover.
4. Provide matched temperature sensors for differential temperature measurement.
5. Outdoor temperature sensors shall be platinum type and have a minimum accuracy of ± 0.5 degrees F from -40 degrees F to 140 degrees F and a measuring range from -20 degrees F to 120 degrees F. Outdoor temperature sensors shall be mounted on the north

side of the building within a ventilated enclosure that protects the sensor from thermal building mass biasing, solar radiation and precipitation without affecting performance.

D. Relays

1. Control relays shall be UL Listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL Listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200 percent (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA enclosure suitable for location when not installed in local control panel.

E. Override Timers

1. Override timers shall be electronic UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated type with LCD display unless otherwise specified.

F. Current Transformers

1. AC current transformers shall be UL/CSA recognized and completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for ±1 percent accuracy at 5 A full scale output.
3. Transformers shall be split-core type for installation on new or existing wiring.

G. Voltage Transmitters

1. AC voltage transmitters shall be self-powered single loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
2. Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ±1 percent full-scale accuracy with 500 ohm maximum burden.
3. Transmitters shall be UL/CSA recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.

H. Control Transformers

1. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish overcurrent protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

I. DC Power Supply

1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in overvoltage and overcurrent protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure. a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration. Line voltage AC input Class 1 (120 VAC or greater) units shall have UL recognition and/or CSA listing.

J. Surge and Transient Protection

1. Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.
2. Power Line Surge Protection
    a. Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:
        1) The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
        2) The device shall react within 5 nanoseconds and automatically reset.
        3) The voltage protection threshold, line to neutral, shall be no more than 211 volts.
        4) The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.
        5) The primary suppression system components shall be pure silicon avalanche diodes.
        6) The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
        7) The device shall have an indication light to indicate the protection components are functioning.
        8) All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
        9) The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
        10) The device shall comply with IEEE C62.41, Class "B" requirements and be tested according to IEEE C62.45.
        11) The device shall be capable of operating between -20 degrees F and +122 degrees F.
3. Telephone and Communication Line Surge Protection
    a. Provide surge and transient protection for DDC controllers and BAS network related devices connected to phone and network communication lines, in accordance with the following:
        1) The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges.
        2) The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.
        3) The device shall be installed at the distance recommended by its manufacturer.
4. Controller Input/Output Protection
    a. Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

K. Current-Operated Switches and Relays

1. Current-operated switches and relays shall be self-powered, solid-state with adjustable trip current. The switches and relays shall be selected to match the current of the motor application and output requirements of the BAS.
2. Current switches and relays for fan or pump proof shall be fully adjustable and shall have L.E.D. indicators. Form "A" (normally open) relays shall not be polarity sensitive.

    a. For motors controlled by VFD’s, the current switches and relays shall accommodate variable frequency drive (VFD) outputs down to 6 HZ without contact chatter, with an adjustability range compatible with the motor application and operation. VFD motor loads of less than 1.5 amps may be multi-wound around current relay to increase "sensed" amperage to minimum setpoint for activation.

b. For EC Motors, the current switches and relays shall be specifically manufactured for EC Motors, and adjustable to accommodate the motor's "keep alive current". Coordinate switch and relay selection with the equipment and motor vendors.

L. Door Switches

1. Non-locking rod actuated door switch shall be SPDT, 10 Amps, screw termination, 250VAC voltage rating, UL Recognized.

2. Magnetic door switch shall be SPDT, 250mA @ 30VAC/DC rating.

M. Pressure transducers

1. Transducer shall have linear output signal. Zero and span shall be field adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50 percent greater than calibrated span without damage.
3. Air velocity pressure sensors shall use differential pressure to determine airflow rate and have repeatability within 1 percent of reading and an accuracy of ± 5 percent of range. The velocity range shall be from 0 to 3250 FPM.

N. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application, or as shown.

2.3 Control Dampers

A. Control dampers shall be parallel or opposed blade type as specified below or as scheduled or detailed on drawings.

1. Unless otherwise shown on drawings as opposed blade, outdoor / return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct air-streams toward each other.
2. Relief air and other modulating dampers shall be opposed blade type where modulating operation is required of the dampers.
3. Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.
4. Dampers shall be made to required / specified size without blanking off free area.
5. Outside air dampers and relief air dampers shall be spring return normally closed. Return air dampers shall be spring return normally open.

B. Frames shall be 4 inches x 1 inch x .080 inch (minimum) 6063T5 extruded aluminum hat channel with mounting flanges on both sides of the frame. Each corner shall be reinforced for maximum rigidity.

C. Blades shall be airfoil type 6063T5 extruded aluminum (maximum 6 inches depth) with integral structural reinforcing tube running full length of each blade.

D. Bearings shall be maintenance free and made of a resin-polycarbonate combination.

E. Seals shall be silicone type on all dampers exposed to outdoor air condition (outside air, relief air and dampers directly behind louvers). Seals on all other dampers shall be TPE/EPDM. Adhesive or clip-on type blade seals are not acceptable. Blade seals shall be field replaceable.

F. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.

G. Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws. Linkage attached to blade faces are not acceptable.

H. Axles shall be hexagonal (round not acceptable) to provide positive locking connection to blades and linkage.

I. Submittal shall include leakage, maximum airflow and maximum pressure ratings based on AMCA Publication 500. Dampers shall be tested and certified in accordance with AMCA 511 for Air Performance and Air Leakage. Parallel blade dampers shall be selected with a damper characteristic ratio of 2.5. Opposed blade dampers shall be selected with a damper characteristic ratio of 10. Include approach velocity, correction factor, pressure drop at 1500 fpm, and free area ratio on damper submittal.

J. Provide a damper operator for each panel. No jack shafting is permitted. Damper provided for direct coupled actuators shall have extended shafts.

K. Outside air and relief air dampers shall be insulated and thermally broken with an air leakage rating not to exceed 8 cfm/sq. ft. at 4 inches differential static pressure. Damper shall be a Tamco Series 9000 SC, Ruskin TED50 Series, Greenheck ICD or approved equal.

L. Return air and other control dampers shall be aluminum air foil and frame construction. Leakage rate shall not exceed 8 cfm/sq. ft. at 4 inches differential static pressure. Dampers shall be a Tamco Series 1000, Ruskin CD-50, Greenheck VCD or approved equal.

M. Gas detection system shall provide Carbon monoxide (CO) detectors and Nitrogen dioxide (NO2) detectors. Basis of design shall be Brasch. Gas detection system shall be interlocked with exhaust fan and outside air damper operation.

PART 3 - EXECUTION

3.1 Examination

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

C. Examine the project drawings and specifications. If head room or space conditions appear inadequate, or if any discrepancies occur between the plans and the temperature controls work and the plans and the work of others, then report these discrepancies to the Engineer and obtain written instructions for any changes necessary to accommodate the temperature controls work with the work of others. Any changes in the work made necessary by the failure or neglect to report such discrepancies shall be made by and costs borne by this Contractor.

3.2 Installation Of Sensors

A. Install all sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Mixed air temperature sensors shall be located a minimum of 12 inches in front of 1st downstream coil (to prevent false reading of M.A.T.).

F. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across face area. Each bend shall be supported with a capillary clip.

G. Low limit thermostats (freezestats) shall be installed in a serpentine manner horizontally across the coil face at 1 ft. centers. Each bend shall be supported with a capillary clip. Provide minimum 1 ft. of sensing element for each 1 ft. of coil area. Freezestat controller shall be located outside of airstream and installed in strict accordance with manufacturer's instructions. For freezestats with auto-reset (refer to para 2.2-B.3 or control sequences), provide indoor NEMA 1 panel to house latching control relay, with reset button and light on face of panel. The latching relay shall have separate contacts for latching circuit (N.O.), AHU / fan safety circuits (N.C.) and DDC alarm input (N.O.). The circuit shall be arranged to automatically reset after power failure. For outdoor units, mount panel in mechanical room. For indoor units, mount panel on or near associated AHU.

H. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells. All duct mounted sensors in externally insulated ducts shall be installed in insulated J-boxes (or J-boxes with 1 inch thick ductboard between it and duct) to afford access (and not be covered with insulation).

I. Install outdoor air temperature sensors on north wall complete with sun shield at designated location.

J. Differential Air Static Pressure

1. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable), or to the location of the duct high-pressure tap and leave open to the plenum.
2. Return Duct Static Pressure: Pipe the low-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor.
3. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover at the specified location. Outdoor air pressure sensing points shall be located on each side of the building and piped together in a common manifold.
4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.3 Actuators

A. Mount and link control damper actuators per manufacturer's instructions.

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.
4. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
5. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.4 Local Control Panels

A. Local control panels shall be provided for the equipment being controlled. Panel shall be mounted in mechanical, electrical rooms or electrical closets. Mount panels on wall, columns or independent supports near each respective unit. Do not mount on the unit proper unless the unit has internal jam isolation and the control panel and unit have been designed for direct mounting.

3.5 Identification Of Hardware And Wiring

A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2 inches of termination with the DDC address or termination number.

B. Permanently label or code each point/object of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 0.50 inch letters on laminated plastic nameplates.

D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

E. Identify room sensors relating to terminal box or valves with nameplates.

F. Manufacturers' nameplates.

G. Identifiers shall match record documents.

H. Upon completion of the project, furnish a complete set of these drawings and diagrams, framed under clear plastic, and hang on the wall of the Mechanical Equipment Room where directed.

END OF SECTION

23 09 47 CONTROL POWER AND WIRING FOR HVAC

PART 1 - GENERAL

1.1 Provide all electrical wiring, both line voltage and low voltage, which is required to perform the automatic control functions.

1.2 Where power sources are required beyond sources explicitly shown on the Division 26 drawings, these shall be provided under the Division 23 Contract. Where auxiliary contacts are required on starters to perform the required functions these, too, shall be provided under the Division 23 Contract. Where not provided under Division 26, auxiliary external relays may be provided in lieu of auxiliary contacts.

1.3 Wiring, both line and low voltage, shall comply with The National Electric Code (NEC) and shall be subject to approval of the local code enforcing authorities.

1.4 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

1.5 Install all equipment in readily accessible locations as defined by the National Electrical Code (NEC).

1.6 Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

1.7 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

1.8 Provide tagging or labeling of conduit so that it is always readily observable which conduit was installed or used in implementation of this Work.

1.9 All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 5 cm [2 inches] of termination with the DDC address or termination number.

1.10 Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible. Where communication wire must cross high power wire (deemed as 110VAC or greater) it must do so at right angles.

1.11 All shields shall be grounded (earth ground) at one point only to eliminate ground loops. All shield grounding shall be done at the controller location with the shield at the sensor/device end of the applicable wire being left long and “safed” off in an appropriate manner.

1.12 There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted pairs (24awg) in accordance with the manufacturer’s wiring practices.

PART 2 - PRODUCTS

2.1 Wire, conduit and installation methods shall conform to applicable provisions of Division 26 - Electrical except that wiring smaller than No. 12 and conduit smaller than 0.75 inch are permitted as appropriate for the application.

2.2 Communication wire shall meet the following requirements as a minimum. Control system manufacturers recommendations which exceed these requirements shall govern.

A. Category 6 plenum rated, 4 twisted pair, non-shielded (UTP) station cable (capable of transmission speeds up to 100 Mb/s) shall be used for control system networking. Cable shall be insulated with FEP material and sequentially marked at 2 foot intervals. Color as selected by Owner.

Gauge	24 AWG
Nominal O.D.	.17 in.
Min. Bend Radius	.5 in.
Standards/Certification	UL 444, UL 13 EIA/TIA 568, Cat. 5 PN-2841
DC Resistance	9.38 ohm/100 m
Maximum mutual capacitance of a pair @ 1 Khz	5.6 nF/100 m
Unbalanced Capacitance per pair to ground @ 1 Khz	330 pF/100 m
Impedance	100 ohm ± 15%
Structured Return Loss 10/100 Mhz	23/16 dB/100 m
Attenuation (max at 100 m)	4.1 dB @ 4 Mhz 8.2 dB @ 16 Mhz 22.0 dB @ 100 Mhz
NEXT (min. at 100 m)	53.0 dB @ 4 Mhz 44.0 dB @ 16 Mhz 32.0 dB @ 100 Mhz
Propagation Delay (min. @ 10 Mhz)	5.7 ns/m

2.3 Wiring and raceways

A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.

B. All insulated wire to be copper conductors, UL labeled for 90 degrees C minimum service.

C. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

D. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

E. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

F. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

G. Sensor and/or signal cabling for controller I/O shall be multi-conductor type, stranded copper conductors, shielded, with plenum rated outer jacket. Conductor size shall be as recommended by the manufacturer for cable length and device power consumption.

2.4 Provide an Uninterruptible Power Supply system battery backup for each controller and its respective input/output devices. Uninterruptable Power Supply shall protect against blackouts, brownouts, surges and noise.

A. Uninterruptable Power Supply shall include LAN port and modem line surge protection.

B. Uninterruptable Power Supply shall be sized for a 7-minute full load runtime, 23-minute ½ load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2 – 4 milliseconds or less.

C. Uninterruptable Power Supply shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90 percent recharge capability in 2 – 4 hours. Suppression response time shall be instantaneous. Uninterruptable Power Supply low voltage switching shall occur when supply voltage is less than 94 volts.

D. Provide a maintenance bypass switch that allows input voltage to bypass the Uninterruptable Power Supply and directly power the connected equipment if an abnormal condition prevents the Uninterruptable Power Supply from supporting the load, or if the Uninterruptable Power Supply is required to be taken out of service. Provide all software, cables, peripherals, etc. for a complete system.

PART 3 - EXECUTION

3.1 All line voltage wiring and low voltage wiring in the following locations and applications shall be run in conduit regardless of local building code allowances:

A. Mechanical Rooms, Electrical Rooms and other similar equipment rooms.

B. Vertical risers (except if contained within a 2-hr or greater rated shaft).

C. Open Areas where wiring will be exposed to view or tampering.

D. Outdoors.

E. Exhaust Method Smoke Control Systems (all wiring run in conduit, regardless of location or path).

Other than the specific locations and applications above, low voltage wiring concealed above accessible ceilings may be run without conduit. Open wiring dropping into walls shall be run in conduit. Thermostats shall be installed on a single gang box and conduit shall be installed to extend into the plenum. Open wiring shall be bundled and supported at 3 ft. maximum intervals with a system of J-hooks. Cable trays installed by other trades may only be used when approved by Owner and Technology Installer. Open wiring in air plenums shall be rated for such use and so labeled.

3.2 Thermostats and other wall mounted sensors shall be installed on a single gang box. EMT conduit shall be installed from the wall box to the plenum; cabling within the wall shall be in conduit.

3.3 Provide electrical circuits from the nearest appropriate “Legally Required” or “Owner Optional” emergency electrical panel to serve control panels, transformers, and other control equipment and devices. Circuits serving control panels and transformers for low voltage service shall be independent and used for no other purpose. Circuits for VAV DDC controllers and other unitary type controls need not be on “Legally Required” nor “Owner Optional” emergency power. Provide circuit wiring from the electrical panel. These circuits shall be clearly identified at the panels. Coordinate with Division 26.

3.4 When utilizing an Owner's network for communication, provide network cable and pathways from each control panel to tech closets (or from panel to panel as required by system architecture) to ensure a complete and operational system. In addition, provide independent temporary means of communication (this may include but is not limited to all routers, switches, modems and temporary means of internet communication) as needed to ensure system can be fully tested, commissioned, used as temporary heating/cooling and balanced without reliance on the Owner's or other trade systems being operational, as dictated by the construction schedule. Once permanent systems are completed by other trades, coordinate and assist in transference of communication pathways to permanent systems. Network cable and pathway shall comply with Division 27 specification requirements.

END OF SECTION

23 09 93 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 Implemented Sequences of Operation shall be in compliance with ASHRAE 90.1-2019, unless deviated by the sequences with-in. Any additional deviations must be reviewed with the Engineer prior to implementation.

1.2 Provide all equipment (valves, dampers, actuators, controllers, etc.) required to perform the functions specified unless noted herein or elsewhere in these contract documents. Electric motor driven equipment (pumps, chillers, compressors, cooling towers, etc.) shall be provided with minimum on (run) and minimum off timers to prevent short cycling of the equipment (coordinate with equipment manufacturer's).

1.3 All DDC system control points shall have a default value in case of sensor failure or logic error. All controlled devices shall fail safe on loss of control. All setpoints and parameters shall be fully adjustable from the end user / owner interface.

1.4 Refer to Section 23 09 23 for Sequences of Operations meeting.

1.5 These sequences are intended to be performance based. Implementations that provide the same functional result using different underlying detailed logic will be acceptable, pending Engineer review.

1.6 Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent windup.

1.7 When a control loop is enabled or reenabled, it and all its constituents (such as the proportional and integral terms) shall be set initially to a neutral value.

1.8 A control loop in neutral shall correspond to a condition that applies the minimum control effect, i.e., valves/ dampers closed, VFDs at minimum speed, etc.

1.9 When there are multiple outdoor air temperature sensors, the system shall use the valid sensor that most accurately represents the outdoor air conditions at the equipment being controlled.

1.10 Outdoor air temperature sensors at air-handler outdoor air intakes shall be considered valid only when the supply fan is proven ON and the unit is in occupied mode or in any other mode with the economizer enabled.

1.11 The outdoor air temperature used for optimum start, plant lockout, and other global sequences shall be the average of all valid sensor readings. If there are four or more valid outdoor air temperature sensors, discard the highest and lowest temperature readings.

1.12 The term “proven” (i.e., “proven ON”/“proven OFF”) shall mean that the equipment’s DI status point (where provided, e.g., current switch, DP switch, or VFD status) matches the state set by the equipment’s DO command point.

1.13 The term “software point” shall mean an analog variable, and “software switch” shall mean a digital (binary) variable, that are not associated with real I/O points. They shall be read/write capable (e.g., BACnet analog variable and binary variable).

1.14 The term “control loop” or “loop” is used generically for all control loops. These will typically be PID loops, but proportional plus integral plus derivative gains are not required on all loops. Unless specifically indicated otherwise, the guidelines in the following subsections shall be followed.

1.15 Use proportional only (P-only) loops for limiting loops (such as zone CO2 control loops, etc.).

1.16 Do not use the derivative term on any loops unless field tuning is not possible without it.

1.17 To avoid abrupt changes in equipment operation, the output of every control loop shall be capable of being limited by a user adjustable maximum rate of change, with a default of 25% per minute.

1.18 All setpoints, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.

1.19 Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user with appropriate access level (e.g., for testing and commissioning). If hardware design prevents this for hardware points, they shall be equated to a software point, and the software point shall be used in all sequences. Exceptions shall be made for machine or life safety.

1.20 VFD Speed Setpoints. The speed AO sent to VFDs shall be configured such that 0% speed corresponds to 0 Hz, and 100% speed corresponds to maximum speed configured in the VFD. For each piece of equipment, the minimum speed shall be stored in a single software point. This value shall be written to the VFD's minimum speed setpoint every 15 minutes via the drive's network interface; in the case of a hard-wired VFD interface, the minimum speed shall be the lowest speed command sent to the drive by the BAS. Minimum speed setpoints for all VFD-driven equipment shall be determined in accordance with the testing, adjusting, and balancing (TAB) specifications for the following, as applicable: supply fan, return fan, relief fan.

PART 2 - PRODUCTS

2.1 Refer to Section 23 09 23 and 23 09 25 for applicable products.

PART 3 - EXECUTION

3.1 "Occupied", "Unoccupied" and Override Modes

A. Each air-side system shall be scheduled (independently) for "Occupied" and "Unoccupied" modes of operation, unless stated otherwise in the specific system sequences of operations with-in.

B. Automatic controls shall be capable of retaining programming and time settings during loss of power for a period of at least ten hours, and shall include an accessible override that allows temporary operation of each system for up to two hours.

C. The "Occupied" mode of operation shall be scheduled through a time and date calendar function at the DDC system operator workstation. The initial "Occupied" mode schedule shall be in effect Monday through Friday, 7:00 a.m. to 5:00 p.m. unless noted otherwise in the specific system sequences with-in. Coordinate time of day scheduling with Owner. Scheduling software shall be capable of seven different day-types per week.

D. The "Unoccupied" mode shall be in effect whenever the zone or system is not in "Occupied" mode. Activation of the building security system shall also override the zone or system to the "Unoccupied" mode.

E. "Override" mode shall put the zone or system into "Occupied" mode when any of the following occurs:

1. “Occupied” mode initiated through manual override of the “Unoccupied” mode at the programmable thermostat.
2. “Occupied” mode initiated by a zone override device. A zone override device shall be a manually operated button or switch, as defined with-in or on the drawings.

3.2 Adaptive Optimal Start Mode

A. For each air-side system, the DDC System shall utilize space temperature, outdoor air temperature, applicable “Occupied” heating and cooling setpoints and occupancy schedule to continuously adapt itself using a "learning" process to calculate the most optimal start time, up to 4 hours (adjustable) prior to scheduled occupancy time, to allow the average building space temperature to reach the “Occupied” space temperature setpoint determined by the heating or cooling mode. Programs which require manual fine-tuning of each fan system's algorithms shall not be acceptable.

3.3 General Exhaust Fans

Each exhaust fan (and its respective automatic damper) shall be a separate start/stop point of the digital control system unless specifically stated as local manual control only.

3.4 Monitoring and Alarms

The following points shall be monitored and alarmed at the monitoring console and as otherwise specified hereinafter:

A. Point Descriptions:

1. Current Sensing Relays Provide for all rooftop unit supply; all general exhaust fans, destratification fans.
2. High/Low Temperature Alarms on all DDCS temperature sensors with off normal messages.
3. Fire Alarm System Inputs Fire alarm shall be input into the DDCS for information and smoke control mode. Provide wiring from the DDCS inputs to the Fire Alarm System outputs. Coordinate connection points with the Electrical Contractor.

B. When interfacing with equipment providing remote analog inputs or receiving analog outputs to the DDCS or when monitoring requires the installation of external relays at the equipment being monitored, coordinate all requirements such as range, signal condition, grounding, wiring and input impedance with the supplier of the equipment being monitored.

C. Dial Out Alarms – DDCS shall initiate a phone call and print an alarm message at a remote printer, digital pager, or PC operating in terminal mode whenever the system detects a critical alarm. These alarms shall include but not be limited to: RTU freezestat alarm, or heating failure.

3.5 Exhaust fan EF-1 (Quantity of 4)

A. These fans provides ventilation for the garage bay with the purpose of maintaining acceptable levels of carbon monoxide and nitrogen dioxide. When space carbon monoxide or nitrogen dioxide rises above setpoint, fans shall be enabled, and be activated. Fan shall continue to operate until carbon monoxide and nitrogen dioxide levels fall below setpoint, when fan shall be disabled. Minimum run time shall be 30 minutes. Fan operation shall be interlocked with garage louver motorized dampers.

B. A manual “manual-auto” switch wired to wall location shown on drawings, shall select control signal source for motor speed. When the motor is enabled and is indexed to the “manual”

position, the manual speed adjuster of the ECM motors shall provide the control signal for motor speed.

3.6 Destratification Fans F-1 (Quantity of 17 F)

A. Fans shall be controlled from a wall mounted thermostat to operate and cycle fan upon a rise in room temperature.

B. A manual “manual-auto” switch wired to wall location shown on drawings, shall select control signal source for motor speed. When the motor is enabled and is indexed to the “manual” position, the manual speed adjuster of the ECM motors shall provide the control signal for motor speed.

3.7 Heating and Ventilation Unit – ARU-1 & ARU-2

A. System Description

1. The air handling system shall consist of a supply fan with factory provided VFD, outside air damper, filter bank, gas fired furnace.

B. System Enable Conditions:

1. Unit is provided with factory packaged controls.

C. Supply Fan System Control:

1. The supply fan system consists of one fan and one VFD. Refer to 23 05 14 adjustable frequency motor controllers for VFD requirements.
2. A manual “hand-off-auto” switch on the face of the VFD shall select mode of operation. When the selector switch is indexed to the “off” position, the associated fan system shall stop. When the selector switch is indexed to the “on” position and all safeties are normal, the associated fan system shall start and run continuously. When the selector switch is indexed to the “auto” position and all safeties are normal, the BAS shall start and stop the associated fan system.
3. A manual “manual-auto” switch (control pad feature) on the face of the VFD shall select control signal source for motor speed. When the motor is enabled and is indexed to the “manual” position, the manual speed adjustor of the VFD shall provide the control signal for motor speed. When the motor is enabled and is indexed to the “auto” position, the BAS shall provide a proportional plus integral control signal to modulate motor speed to maintain the design cfm.
4. Heating control shall be set point 55 Deg F or below.

D. Outside Air Dampers:

1. When the exhaust fans are off for any reason the outside air damper shall be closed. Dampers shall open fully when the exhaust fans are on. Provide end switch on damper to prove damper position before fan is allowed to start.

E. Gas Heater:

1. Gas heater - Gas heating section to modulate to satisfy the space set point (50 Deg F adjustable).

END OF SECTION

23 09 95 DIRECT DIGITAL CONTROL SYSTEM POINTS LIST

PART 1 - GENERAL

1.1 The following list shall be the minimum points required of the Direct Digital Control System (DDCS). It is not the intent to show all required points. If or when additional points are required to accomplish the sequences of control specified, these points shall also be provided. The point types are identified as follows:

DI Contact Input (NO or NC)
DO Contact Output (NO or NC)
AI Analog Input
AO Analog Output
PI Pulsed Input

1.2 Rooftop Unit Points List:

Type	Description	Quantity
AI	Return Air Temperature	1
AI	Mixed Air Temperature	1
AI	Supply Air Temperature	1
AI	Supply Air Static Pressure	1
DI	Supply Fan Status	1
DI	Return Fan Status	1
AO	Supply Fan Volume Control	1
AO	Return Fan Volume Control	1
AI	Air Filter Pressure Drop	1
DI	Freezestat	1
DO	Fan System Start/Stop	1
AI	Space Temperature	*
DI	Smoke Alarm	**

*One sensor for unoccupied control, additional space sensor as shown on drawings. When DDC zone control is specified all zone thermostats shall be DDC inputs.
**For notice of smoke detection at the B.A.S. (in addition to hardwired starter interlock for unit shutdown).

1.3 Exhaust Fan Systems

Type	Description	Quantity
DO	Exhaust Fan Start/Stop	*
DO	Exhaust Fan Garage Damper Closures	*
DI	Exhaust Fan Status	*
DI	Gas detection Alarm	**
DI	Gas detection Damper End Switches	***

*One for each fan system.
**For notice of gas detection at the B.A.S., startup of fan, and opening of associated dampers.
***One for each damper.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

23 21 13 HYDRONIC PIPING

PART 1 - GENERAL

1.1 Hydronic piping systems (condensate drainage) shall be as shown on the drawings and as specified herein. Systems shall include piping, valves, system specialties and accessories.

1.2 Piping systems shall conform to ANSI and State rules for pressure piping where applicable. Welders and fitters shall be fully certified for work performed.

1.3 Refer to Section 23 05 07 Piping Materials and Methods, Section 23 05 29 Hangers and Supports for HVAC Piping and other related sections for required provisions.

PART 2 - PRODUCTS

2.1 Pipe, fittings and joints for the hydronic systems shall be as listed below and as described in Section 23 05 07 Piping Materials and Methods.

2.2 Piping for the various service shall be:

A. Cooling Condensate drainage.

1. Copper – Type C4.

PART 3 - EXECUTION

3.1 Drawings (plans, schematics and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, pipe expansion, pump sizing and other design considerations; therefore, it is imperative that piping be installed as indicated. However, deviations shall be anticipated & expected to accommodate field conditions and as such deviations shall be submitted in writing/diagram form for review by the Engineer prior to installation.

3.2 Refer to Section 23 05 01 Basic HVAC Requirements and other equipment sections for system cleaning and flushing requirements.

3.3 Refer to Section 23 05 07 Piping Materials and Methods for installation of piping and accessory devices and equipment.

END OF SECTION

23 23 00 REFRIGERANT PIPING

PART 1 - GENERAL

1.1 Refrigerant piping and related devices shall be provided extending between SHP units and HPCU units.

1.2 Refrigerant piping shall conform to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition.

1.3 Pipe arrangement, devices and sizing information shown on the drawings is limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Drawings shall be submitted to the Engineer for review with the equipment shop drawings.

1.4 The equipment supplier shall provide piping installation instructions to the Installing Contractor and supervision as needed to ensure that the piping system is installed in accordance with the equipment manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 Refrigerant tubing shall be Type "ACR" hard seamless copper thoroughly cleaned and dehydrated for use with the refrigerant used. Tubing which has not been so prepared and sealed or which has been open to the atmosphere for any length of time shall not be used. All changes in direction of piping shall be made with wrought copper fittings.

2.2 Refrigerant devices and specialties shall be specifically designed for refrigerant applications and of construction pressure class consistent with the duty imposed.

A. A thermal expansion valve shall be provided in the liquid line at each evaporator coil if an expansion valve or device is not integral with the unit. The expansion valve shall be diaphragm type with external equalizer and external superheat adjustment.

B. A liquid line electric solenoid valve or a "hard shutoff" thermal expansion valve shall be provided where the liquid line exceeds 50 ft. in length.

C. All refrigerant access ports shall be fitted with locking-type tamper-resistant caps.

PART 3 - EXECUTION

3.1 Pipe arrangement, devices and sizing information shown on the drawings is schematic in nature, limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Exact routing, and pipe quantities and sizing shall be per manufacturer’s requirements. Refrigerant piping shall conform to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition. Drawings shall be submitted to the Engineer for review with the equipment shop drawings. Exact routing, and pipe quantities and sizing shall be per manufacturer’s requirements.

3.2 All joints shall be brazed using silver brazing alloy while flowing an inert gas such as dry nitrogen through the piping.

3.3 Piping shall be hung from the building structure with clevis hangers and rods as described in 23 05 29 Hangers and Supports for HVAC Piping. Hangers for insulated pipe shall be oversized and a sheet metal saddle with belled ends incorporated to protect the insulation.

3.4 Each refrigerant piping system shall be 24-hour positive-pressure leak tested with dry nitrogen at 600 psi, and then 24-hour negative-pressure tested to between 200 and 500 microns, or per equipment manufacturer's requirements, whichever is more stringent. The test pressures shall be demonstrated to be maintained for at least 24 hours for each pressure test, with starting and ending pressures recorded and documented. A system shall be considered "proven-tight" when there is no more than a 40 psig loss during the positive-pressure test, and no more than a 50 micron rise for the negative-pressure test. If a test fails, triple nitrogen purge and repeat the test after the leak has been repaired. Once a system has been "proven-tight", the system shall then be purged and charged with the required amount of refrigerant per the equipment manufacturer's instructions.

END OF SECTION

23 31 13 HVAC DUCTWORK

PART 1 - GENERAL

1.1 Ducts, sheet metal plenums and associated devices, accessories and work items shall be provided as shown on the drawings and as specified hereinafter.

1.2 Ductwork, materials, construction, reinforcing and installation shall conform to SMACNA HVAC Duct Construction Standards, latest edition, and other applicable SMACNA standards. In addition, duct systems, components and accessories shall comply with applicable provisions of NFPA 90A, 90B, 96 and 255, and UL 181, 181A, and 181B, including smoke and flame ratings.

1.3 Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 Refer to the Duct Construction and Sealing Schedule on the drawings for information pertinent to the various duct systems, such as duct materials, SMACNA pressure class, seal and leakage class, external insulation, duct liner, etc.

1.5 Refer to the drawings for ductwork that is to be internally lined. Ductwork shall only be internally lined where scheduled or noted on the drawings.

1.6 Refer to 23 05 05 Firestopping for requirements related to non-fire dampered ductwork penetrating fire rated walls and partitions.

1.7 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Sheet metal shall be lock forming quality galvanized steel, ASTM A924/A924M and A653/A653M, G60 coating designation, 24 gauge minimum, except as otherwise noted or specified. Other materials and construction for special applications required are as shown on the drawings and specified below.

2.2 Flexible duct shall be installed as detailed on the drawings and shall not pass through any wall, floor, or ceiling. Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly.

A. Flexible air (duct) connectors for galvanized steel ductwork shall be:

Constructed of galvanized steel spiral wire mechanically locked to an airtight laminated aluminum foil, fiberglass and aluminized polyester duct fabric. Duct shall be rated at a minimum of 10 inches w.c. positive pressure and 4 inches w.c. negative pressure. Length shall be limited to 5 feet unless noted otherwise.

Insulated flexible duct shall have 1 inch thick R-4.2 fibrous glass insulation and .10 perm polyethylene vapor barrier outer jacket, equal to Flexmaster Type 5B. Insulated duct assembly shall conform to be UL 181 and listed as Class I Flexible Air Connector.

2.3 Rectangular Ductwork

A. Elbows shall have an inside radius equal to the duct width. Where 90 degrees elbows are shown to be square on the drawings, they shall be square (mitered) with turning vanes, single vane type in lengths 32 inches and less, double wall in longer vanes, installed and supported per SMACNA. Elbows less than 90 degrees shall be radiused. Non-radiused elbows less than 90 degrees, with or without turning vanes, are not permitted.

B. Square Tee fittings shall include turning vanes. The widths of the two branch ducts shall add up to the width of the main duct, and the duct depths shall remain constant. Turning vanes shall be single vane type in lengths 32 inches and less, double wall in longer vanes, installed and supported per SMACNA.

C. Offsets and transitions shall conform to SMACNA. Unless shown otherwise on plans, transition angles shall be limited to 60 degrees on converging transitions as measured on the interior, and 30 degrees on diverging transitions as measured on the interior.

D. Branch take-offs, where not detailed otherwise, shall be with a static boot (45 degrees clinch collar) per SMACNA. Straight tap take-offs are not permitted.

E. Divided flow branches shall conform to SMACNA. Bull head tees without vanes are not permitted.

F. Manufactured duct connectors similar to Ductmate Industries “25”, “35” and “45” may be used on rectangular ductwork except where welding or brazing is specifically required. Adhere strictly to manufacturer’s instructions. SMACNA duct gauge thickness and reinforcing shall be maintained when using this joining method, or the manufacturer’s requirements, whichever is more stringent. Connector components shall be constructed from same material as the duct section being connected.

2.4 Fan Transitions

A. Fan inlet – Maximum 15 degrees diverging as measured on the interior, and 30 degrees converging as measured on the interior, and first duct elbow shall be minimum 2.5 fan inlet diameters away unless shown otherwise on plans.

B. Fan Discharge -- Maximum 15 degrees diverging as measured on the interior, and 30 degrees converging as measured on the interior, and first duct elbow shall be minimum 2.5 fan inlet diameters away unless shown otherwise on plans

2.5 Round Ductwork:

A. Round duct shall be factory or shop formed spiral lock seam, United McGill Air Products "Uni Seal" or equal by Langdon, Semco, Tangent Air, Precision Duct.

B. Elbows and fittings for spiral lock seam round ductwork shall be factory solid welded, equal to United McGill Air Products "Uni Seal" with beaded sleeve transverse joint connectors, or equal by Langdon, Semco, Tangent Air, Precision Duct. For duct systems classified at less than 3” w.c., elbows and fittings may be roll pressed type. Elbows shall be long radius type and, where shown, square type ells shall be mitered with turning vanes. Branch take offs shall utilize a 45 degree entry low loss tap or a conical lateral tap to minimize pressure loss, except that streamlined conical taps may be used where space constraints dictate. Tee fittings shall include elongated proportional turning vanes to equalize airflow around the ells. Wye branches shall be used at end of runs unless shown otherwise. Offsets and transitions shall conform to SMACNA. Transition angles shall be limited to 60 degrees on converging transitions as measured on the interior, and 30 degrees on diverging transitions as measured

on the interior. Divided flow branches shall conform to SMACNA. Bull head tees without vanes are not permitted.

C. Construction, reinforcing, supports, etc. shall either conform to SMACNA or to the duct manufacturer's standards, whichever is more stringent.

2.6 Air device duct connections for round duct branch connections to rectangular sheet metal ducts shall be 24 gauge sheet metal, equal to Flexmaster Series FL, straight side, minimum 24 gauge with and without manual damper, as described on the drawings. When manual damper is provided it shall be minimum 22 gauge with stamped re-enforcements and include .375" square shaft and locking quadrant equal to Ventlok 639 or Rossi "Everlock", with 2" standoff and nylon bushings. Air terminal unit duct connections for round duct branch connections to rectangular sheet metal ducts shall be 24 gauge sheet metal conical type equal to Flexmaster Series CB. Connectors installed on interior lined rectangular duct shall have an integral insulation guard sleeve. Rectangular tap-to-round branch connection with static boot configuration shall be equal to Flexmaster Type STO. Buckley "Air Tite" fittings or similar by "Snap Rite", equal to the specified Flexmaster fittings, with neoprene gasket and adhesive facing, additionally secured with minimum four sheetmetal screws, may be used for air device duct taps to rectangular sheet metal duct which is not internally lined.

2.7 Duct sealants containing asbestos are prohibited. All duct sealants, tapes and connectors shall be listed and labeled in accordance with UL 181A, 181B or 181C as applicable to the application. Duct sealant materials shall be one or more of the following (compatible with the application):

A. LEED Compliant solvent based sealers and mastics equal to Design Polymerics, with a maximum VOC content of 50 grams/liter.

B. Water base duct sealers and mastics equal to United McGill or Foster Products when the installation environment is above 40 degrees F.

C. Acetone based duct sealers and mastics, equal to Precision Adhesives, when the installation environment is between 0 degrees F and 40 degrees F, zero reportable V.O.C.'s.

D. Mineral impregnated fiber tape with liquid sealant duct joint sealer equal to that manufactured by Hardcast, Inc., Two Part II Sealing System, maximum V.O.C. of 135 g/l.

PART 3 - EXECUTION

3.1 Duct thickness, construction, reinforcing, support and installation including cabling systems, shall conform to SMACNA HVAC Duct Construction Standards, latest edition and other applicable SMACNA standards. Cable support systems are not allowed. Duct reinforcing shall be external to the duct except that rectangular ducts of 3 inches s.p. class or greater with a dimension exceeding 48 inches may utilize internal tie-rod supports in accordance with SMACNA. Only round tubing, rods or conduit is permitted as tie-rods, utilizing the minimum diameters required by SMACNA.

3.2 Transverse joints and longitudinal seams shall be assembled with sealant to conform to SMACNA sealing requirements as indicated in the Duct Construction Schedule on the drawings. Selection of sealant materials shall be compatible with the application. Sealants shall be applied in accordance with manufacturer's recommendations, including application temperature ranges.

3.3 Attachment of hangers and straps to the structure shall be with:

A. Beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to ensure permanent attachment.

B. Unistrut type channel support system may be utilized. Channel shall be pre-set or attached to the structure with inserts or clamps.

C. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.

D. Attachment to manufactured trusses, joists, purlins, and other engineered structural members and supports shall be done in strict accordance with the structural engineer's or manufacturer's recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural engineer or manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances. In the case of existing trusses, the structural engineer must review and approve hanger attachment methods.

3.4 Flexible air (duct) connectors shall be attached to metal duct with Panduit nylon banding straps or stainless steel clamps. Nylon banding straps shall be tightened utilizing a cable tie gun. Outer jacket of insulated flexible duct shall be closed at the ends with sealant and nylon banding straps or U.L. listed aluminum foil duct tape equal to Nashua No. 617022 with UL 181 listing printed on the face. Maximum length shall be 3 ft. with support at 2 ft. maximum spacing. Duct shall be free of sags and sharp bends. Utilize flexible duct elbow supports at all elbows. Flexible supports shall be UL listed for ceiling return air plenum use per UL 2043, UL 723 or ASTM E84, as manufactured by Titus (Flexright) or Thermaflex (Flex Flow) or approved equal. Independently supported radius'd sheet metal elbows may be used in lieu of flexible duct elbow supports when installed directly on air devices.

3.5 Flexible air (duct) connectors shall not be installed:

A. Where ductwork is exposed.

B. Thru any wall, ceiling, floor or fire rated or smoke rated assembly.

C. In the immediate vicinity of, and connecting to, air devices in fire rated ceilings where the assembly details require steel ductwork.

3.6 Duct and plenum connections to air supply, return or exhaust units and fans (other than power roof ventilators or any Type I grease duct fan) shall be made with a 4 inches wide intervening section of flexible incombustible fabric equal to Ventfabrics "Ventglas", to prevent the transmission of fan noise and vibration to the ductwork. Fastening shall consist of angle clamps and bolts made up to be air tight similar to Ventfabrics "Metaledge". Duct connections to Type I grease duct fans shall be flanged and gasketed with material rated for no less than 1500 degF.

3.7 Duct access doors shall be provided for access to equipment, damper operators, devices and instruments inside the duct, at each fire damper, smoke damper and duct smoke detector (refer to Electrical drawings) and where otherwise shown. A wall or ceiling access panel shall be provided where duct access is required thru a wall or inaccessible ceiling. Refer to 23 05 04 Basic HVAC Materials and Methods for such access panels.

3.8 Access door and fire damper shall be so arranged and located such that the spring catch and fusible link are accessible when the damper is closed. The door shall be sized to permit entry of arms or body in resetting of the damper. Special consideration must be given for larger dampers and spring loaded horizontal dampers.

3.9 Coordinate openings required for the passage of ductwork thru walls, partitions, floors and roofs with the General Contractor. Sleeves are not required except as stated below.

3.10 Floor sleeves for ductwork shall project 4 inches above the finished floor in equipment rooms and areas of similar usage, and shall form a waterproof seal. Exceptions shall be at locations where the opening is protected from drainage falling thru by means of concrete curbs or shaft walls. Provide 4 inch high x 4 inch wide concrete curbs with beveled edges to protect floor openings related to work in equipment rooms or an equally effective waterproofing metal curb.

3.11 Sheet metal sleeves in conjunction with fire dampers shall be placed in walls and floors to pass ductwork.

3.12 Where a fire damper is not required in a duct penetrating a fire rated wall or partition, the opening shall be fitted with a sleeve conforming to the requirements of the firestopping assembly. Refer to 23 05 05 Firestopping.

3.13 Annular spaces around ducts or duct insulation passing thru non-fired rated walls and partitions shall be closed with caulking or other compatible material to retard the passage of smoke. Annular spaces around ducts not fitted with fire dampers that pass thru non-fire rated floors shall be similarly closed.

3.14 Stored ductwork shall be blocked up off the ground and completely covered with visqueen. Open ends of both stored and erected duct shall be capped or covered with visqueen secured with duct tape before the end of each day's work to preclude contamination or entry of foreign materials. Factory made covers with elastic banding as manufactured by Duct Cap are also an acceptable means for temporary duct closure.

3.15 The duct system shall be free of construction debris and new ductwork shall comply with level “B”, the Intermediate Level of the latest edition of the SMACNA Duct Cleanliness for New Construction Guidelines.

3.16 Where duct surfaces can be seen thru grilles, registers and diffusers, the inside of the duct shall be coated with flat black paint before the device is installed, to eliminate obtrusive appearances.

3.17 Ductwork and piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment in accordance with The National Electric Code.

3.18 Coordinate duct layout carefully with other trades to avoid conflict with structural elements, lighting and plumbing heating piping. Flattening of ductwork and offsets to fit ductwork in available space is generally shown. In the absence of such, arrange the ductwork to maintain concealment and allow ceilings and lights to be installed as intended. Do not hang ductwork until possible interference with electrical and mechanical trades have been resolved. Having ductwork fabricated and delivered in advance shall not be justification for interference with other trades.

END OF SECTION

23 33 00 AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 Ductwork accessories specified herein shall include manual balancing dampers. Refer to the drawings for scope and application.

1.2 Balancing dampers are also specified to be furnished with "spin-in" duct taps specified in Section 23 31 13 HVAC Ductwork and in Section 23 37 00 Air Outlets and Inlets. Automatically controlled dampers are specified in the temperature controls sections and also specified as integral components of air handling equipment, fans, VAV control units and other such equipment.

1.3 Manual balancing dampers, in addition to those shown, which will be required to effect a positive balancing of air in the system shall be provided in the ductwork. The company or agent who is to balance the air systems shall call the HVAC Contractor's attention to requirements for additional balancing dampers which are deemed necessary.

PART 2 - PRODUCTS

2.1 Dampers and accessory items shall be constructed of galvanized steel.

2.2 Balancing dampers shall be single cross-blade up to 12 inches blade width and in larger sizes, multiple blade type 6 inches maximum width with opposed blade arrangement. Dampers shall have a full length continuous drive shaft and be controlled by a locking quadrant positioner with handle and minimum .375” square shaft, equal to Rossi “Everlock” or Ventlok #641 and for externally insulated ducts Rossi “Everlock” with 2” stand-off or Ventlok #644. For ductwork classified as 2” and greater, provide HiVel Ventlok Acorn Nut, End Bearing and gasket hardware.

PART 3 - EXECUTION – NOT USED

END OF SECTION

23 34 00 HVAC FANS

PART 1 - GENERAL

1.1 Fans shall be provided as specified below and shown on the drawings, complete with motors, drives and associated devices.

1.2 Fans shall be constructed, rated and labeled in accordance with AMCA Standard 210 67 and AMCA 300. Fans shall be statically and dynamically balanced throughout the operating range. The class of the fan provided shall be adequate for the duty specified plus a 25 percent increase in static pressure. Shop drawing submittals shall state maximum fan RPM for fan class provided. No infringement will be allowed on this requirement. Submittals shall include fan curves showing operating point(s), system curves, and surge lines.

1.3 Fans with Electronically Commutated Motors (ECM's) shall be selected such that the maximum available motor RPM shall at minimum accommodate 10% additional fan CFM at a 21% increase in fan static pressure, over what is specified as the duty point. This elevated performance point shall also not exceed the motor's Hp limitations or the fan's construction class. Shop drawing information shall reflect these requirements. Motor speeds shall be adjustable in the field, and any hard programmed limitations of motor speed or fan performance shall be based on the required elevated performance stated above.

1.4 Classification for Spark Resistant Construction shall conform with AMCA 99.

1.5 Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment and Section 23 05 31 HVAC Equipment Drives for required provisions.

1.6 Refer to Section 23 05 49 Vibration Control for HVAC for vibration isolator types.

1.7 Provide dimensional drawings and product data on each exhaust fan assembly. Provide fan curves for each fan at the specified operation point with the flow, static pressure, and horsepower clearly plotted. For multiple fan assemblies, fan curves shall be adjusted to show assembly operation.

1.8 Dampers shall be tested and licensed for air performance and leakage in accordance with ANSI/AMCA standard 500-D and AMCA publication 511.

1.9 Equipment shall carry an all-inclusive manufacturer's parts and labor warranty for a period of one (1) year(s) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. The all-inclusive parts and labor warranty for ECM's and associated controllers shall be for a period of 5 years. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol, or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer's authorized service agent.

PART 2 - PRODUCTS

2.1 Induction motors 1 HP and larger shall be "premium efficiency" series motors. Motors shall be 1750 rpm unless specifically noted otherwise. Drives and couplings shall be protected with guards conforming with OSHA standards. Motors connected to VFD's shall comply with 23 05 13 Electrical Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer. Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment.

2.2 Electronically Commutated Motors (ECM's) shall be maximum 1750 rpm unless specifically noted otherwise. Refer to 1.3 above and Section 23 05 13 Electrical Requirements for HVAC Equipment. ECM's shall be variable speed motors with motor-mounted interface with manual potentiometer that allows minimum 5:1 turn down of motor speed, setting of minimum motor speed, and can accept a 0-10VDC signal from an external source to vary the motor speed.

2.3 The following lists types of fans, related construction features and manufacturers. All fans of any one listed type shall be of the same manufacturer.

A. Type C2 - In Line Centrifugal
In line centrifugal fan shall consist of a backwardly inclined fan wheel, motor, adjustable "V" belt drive (except fans with 13 inches diameter or smaller wheel may be direct drive), belt guard, motor disconnecting means, inlet cone, gravity backdraft damper, square sheet metal housing with 1 inch acoustical lining, and mounting brackets for suspension mounting. Housing shall be galvanized or prime coated and finished with enamel paint.

Direct drive units shall be provided with a solid state speed controller with off position, and cover plate. Coordinate installation with Division 26.

Vibration isolators shall be type as indicated on the drawings.

Fans shall be manufactured by Greenheck, PennBerry, Acme, Cook.

B. Type D1 - Power Roof Ventilator
Power roof ventilator shall consist of a spun aluminum weather hood, counterflashing base, vertical shaft open centrifugal wheel, adjustable "V" belt drive (except fans with 13 inches dia. or smaller wheel may be direct drive) resiliently mounted motor, motor disconnecting means in the motor compartment, motorized backdraft damper and bird screen.

A metal roof curb with straight sides and wood nailer on top shall be provided with each fan. Provide wood cant strips around the curb only if recommended for the roofing system. Curb shall be insulated type. Curb height shall be such that top of curb extends 12" above the finished roof surface. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

Fans shall be manufactured by Greenheck, PennBarry, Cook.

C. Type F1 - Ceiling Fan
Ceiling fan shall consist of a centrifugal fan or fans with propellor blades, direct connected motor with internal overload protection, motor disconnecting plug, composite housing.

Provide a solid state speed controller with off position and cover plate. Coordinate installation with Division 26.

Fan shall be manufactured by Airius, Greenheck, or approved equal.

2.4 Motorized backdraft dampers, where specified, shall be furnished with an electronic damper actuator with voltage compatible with the fan motor voltage and electric service to the fan. If not compatible, a transformer shall be provided with the fan and damper actuator to afford the appropriate voltage. Where the fan motor is fed from a Variable Frequency Drive controller (VFD) provide a control contactor or relay and extend the control from the VFD damper control output relay to open/close the damper when associated fan motor is started/stopped.

2.5 Motorized backdraft dampers shall be insulated damper with extruded aluminum thermally broken airfoil blades with an AMCA air leakage class rating of class 1A at 1 in. wg and class 1 at 4 in. wg.

Damper shall be parallel blade configuration with the motor actuator mounted outside of the airstream. Dampers shall be Greenheck ICD-44, Ruskin TED50, Tamco 9000 SC, or approved equal.

2.6 Gravity backdraft dampers shall be non-motorized dampers that open and remain open under low velocity conditions. Dampers shall be tested in accordance with AMCA standard 500 and at 1 in. wg have a maximum leakage rating of 20 cfm/ft^2, except dampers where the largest dimension is smaller than 24" air leakage shall be a maximum of 40 cfm/ft^2. Damper provided shall be appropriate for the mounting (vertical or horizontal) and application (exhaust or intake) and shall be parallel blade configuration. Dampers shall be Greenheck WD series, Ruskin BD2 or equal by Tamco 7000 CW, or approved equal.

PART 3 - EXECUTION

3.1 Install fans level and plumb, in accordance with manufacturer's written instructions. Support units as described below using the vibration control devices specified in Section 23 05 49 Vibration Control for HVAC.

A. Suspended unit: Suspend unit from structural steel support frame using threaded steel rods and vibration isolation as specified here-in or indicated in the fan schedule.

B. Roof curb mounted units: Set unit on the curb and fasten the fan base to the curb. Roof support curbs shall be installed and leveled and secured to the roof deck/structure. Roof insulation and roofing shall be installed at the curbs by the roofing Contractor. Provide wood cant strips around the curb only if recommended for the roofing system.

3.2 Arrange installation of fans to provide access space around fans for service and maintenance.

3.3 Adjust damper linkages for proper damper operation. Motorized backdraft dampers are to be wired to open when the fan operates. Coordinate with Division 26.

3.4 Fans with E.C. Motors shall be commissioned and set-up by a factory authorized technician to meet project requirements, and interface coordinated with the B.A.S.

3.5 Factory furnished devices which are not installed and wired in the factory shall be field installed and wired by Division 23, complete and ready for operation.

3.6 Perform the following operations and checks before start-up.

A. Remove shipping blocking and bracing.

B. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motor starters and disconnects.

C. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Align belts and reinstall belt guards.

D. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.

E. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

END OF SECTION

23 34 23 HVAC GRAVITY ROOF VENTILATORS

PART 1 - GENERAL

1.1 Roof ventilators shall be provided as specified and shown on the drawings, complete with all associated devices.

1.2 Equipment shall carry an all-inclusive manufacturer's parts and labor warranty for a period of one (1) year(s) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner, including any required replacement of fluids, glycol, or refrigerant. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer's authorized service agent.

1.3 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Roof ventilators shall be all aluminum with spun aluminum weatherhead, counterflashing base for curb mounting and bird screen. Relief and exhaust air units, where so noted, shall have the underside of the hood insulated to prevent condensation of the discharge air on the underside of the hood. Refer to drawing schedules for roof ventilator type.

2.2 Roof ventilators shall be all aluminum louvered penthouse type with heavy gauge extruded aluminum louvers on four sides with mitered and welded corners, reinforcing channels on the interior, sheet aluminum top, counterflashing base and interior bird screen. The counterflashing shall be angled up on the inside to afford additional weather protection and condensation troughing. Relief and exhaust air units, where so noted, shall have the underside of the hood insulated to prevent condensation of the discharge air on the underside of the hood. Intake units, where so noted, shall be equipped with filter channels, 2 inches washable aluminum mesh filters and hinged top for accessibility. Ventilator heads shall be equal to Greenheck, PennBarry "Pennhouse". Refer to drawing schedules for roof ventilator type.

2.3 Exterior of the ventilator head shall be custom color selection by architect.

2.4 A metal roof curb with straight sides and wood nailer on top shall be provided with each fan. Provide wood cant strips around the curb only if recommended for the roofing system. Curb shall be insulated type. Curb height shall be such that top of curb extends 12" above the finished roof surface, 18" above for intake applications. For sloped roofs, the curb shall have a built-in slope to match roof slope so that top of curb is level.

2.5 Backdraft dampers, set within the roof curb, shall be counterbalanced gravity type with felted edges to reduce noise for vent air relief or exhaust, furnished with the roof ventilator.

2.6 Roof ventilators shall be manufactured by Acme, Greenheck, PennBarry, Cook,.

PART 3 - EXECUTION

3.1 Each roof curb shall be installed and the ventilator mounted on and secured to the curb. Shim the curb so that the top is level. Ventilators shall be level and plumb in accordance with manufacturer's instructions. Roof support curbs shall be installed and leveled and secured to the roof

deck/structure. Roof insulation and roofing shall be removed and repaired to maintain the integrity of the roofing system. Provide wood cant strips around the curb only if recommended for the roofing system.

END OF SECTION

23 37 00 AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 Air outlet and inlet devices include grilles, registers, diffusers, louvers and special air diffusion devices associated with ceiling and lighting systems.

1.2 Refer to the schedule on the drawings for description, catalog numbers, materials, finishes, accessories, mounting and other details of the devices required.

1.3 Supply air devices in ceilings shall have their backsides externally insulated for condensation control unless already internally insulated. This external insulation shall be field installed, same as that specified for supply air ductwork / factory installed, minimum R-4.2 mineral fiber with foil jacket.

PART 2 - PRODUCTS

2.1 Air distribution devices other than louvers and specialty products shall be Titus, Tuttle & Bailey, Kreuger, Price. All devices of a common type shall be by the same manufacturer.

2.2 Air outlet and inlet devices shall be equal to those specified by catalog number and description in the schedule on the drawings. Dampers shall be galvanized steel, unless otherwise noted, opposed blade configuration. Damper operators shall be concealed screw type. An auxiliary mounting frame shall be furnished with each grille and register except those mounted on exposed ducts or in lay in application. The ceiling grid is a regressed narrow “T” bar system. Lay-in devices shall be designed to fit in the grid.

2.3 Louvers shall be exterior weatherproof drainable type equal to scheduled and shown on the drawings. Louvers shall be assembled entirely by welded, withstand uniform wind loading pressure from a wind speed of 120 MPH, and shall have its beginning point of water penetrating at no lower than 900 fpm thru the Free Area (.01 ounces / sq. ft.), and its pressure drop no greater than .15 inches w.c. at 900 fpm thru the Free Area. Performance data indicating pressure loss and water penetration, derived from AMCA 500 / 550 testing, shall be included with submittals.

A. Aluminum louvers shall be minimum 12 ga. extruded aluminum with R1 caustic etch and finished with Kynar 500 fluoropolymer finish. Custom color is to be selected by the Architect.

B. Bird screen shall 0.50 inch mesh aluminum wire on the interior face of the louver attached at 12 inches centers on the perimeter.

C. Louvers shall be Greenheck ESD-603, Airolite, American Warming, or equal by Construction Specialties, Arrow United, or Louvers and Dampers.

PART 3 - EXECUTION

3.1 Verify & ensure compatibility of ceiling mounted devices with the ceilings and suspension systems (lay in, concealed spline, plaster, drywall, etc.). Verify with the architectural drawings.

3.2 Carefully align square and rectangular devices with the vertical and horizontal building lines. Diffusers shall be attached rigidly to the ductwork. Where connected by flexible ducts, special supports shall be provided as required, either from the ceiling suspension system or by independent suspension wires or rods from the building structure.

3.3 Factory insulation on supply diffusers that is damaged prior to or during installing shall be repaired.

3.4 Inside of ducts behind grilles, registers and diffusers shall be painted flat black, as needed, to eliminate the sight of shiny surfaces.

3.5 Louver assemblies shall be installed in strict accordance with manufacturer's recommendations. Louvers to be installed plumb, square, level and true. Blank off all unused portions of the louver with 14 ga. aluminum and insulate blank off with 1 inch rigid foil faced insulation. Seal blank off areas air tight.

END OF SECTION

23 51 17 BREECHING, CHIMNEYS AND STACKS

PART 1 - GENERAL

1.1 Flue gas breeching and stack shall be provided to conduct flue gases from the unit heaters to the discharge point above the roof, as shown on the drawings.

1.2 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

1.3 Prior to shop drawing submittals, the flue vent manufacturer shall verify that their vent product is approved for use with the installed appliance. Provide documentation with shop drawings.

1.4 The flue system vendor shall provide on-site inspections and support during installation by a factory-trained representative. This shall include a pre-installation meeting on site, a minimum of 1 site visit during installation, and 1 site visit at completion of installation to document that proper draft controls, sloping and draining are in place. Each meeting shall be documented.

PART 2 - PRODUCTS

2.1 The breeching and stack, for positive pressure application, shall be a factory fabricated double wall flue gas conductor system. The flue vent system and its components shall be tested and UL listed as a building heating appliance chimney system. The system shall carry a 10 year warranty.

2.2 Non-Condensing applications – Pipe and fitting shall be double wall with 1 inch air space between. Inner liner shall be 304 stainless steel and outer jacket inside the building shall be aluminized steel. The outer jacket of components outside the building shall be prepared for field priming and painting.

2.3 Condensing Applications - Pipe and fittings shall be double wall with 1 inch air space between. Inner liner shall be AL29-4C stainless steel or 2205 Duplex Stainless Steel, compliant with UL 1738 (condensing duty), and outer jacket inside the building shall be aluminized steel. Entire product shall be suitable for condensing applications and UL 1738 listed accordingly. The outer jacket of components outside the building shall be prepared for field priming and painting. Ells and Tees shall be fabricated to allow for pitching of horizontal runs (88 degree ells and tees) at minimum .25”/LF.

2.4 Pipe and fittings shall be double wall with 0.50 inch air space between. Inner liner shall be aluminum and outer jacket shall be galvanized steel.

2.5 The system shall be custom engineered, complete with straight length pipe, fittings, cleanout and drain assembly at the base of the stack, firestops, wall and roof penetration assemblies, stack cap, wall, floor and roof support assemblies, expansion compensators, and all accessories to provide a complete and operational system.

2.6 The system shall be engineered and manufactured by Schebler Chimney, Selkirk Metalbestos, Metal Fab, or Van Packer.

PART 3 - EXECUTION

3.1 The drawings show the intent of the routing of the venting system. The flue vent manufacturer shall contact the boiler vendor for input on sizing parameters and layout guidance to perform

engineering, pressure and sizing calculations based on the actual equipment selected to ensure proper system venting performance.

3.2 Submit for review the resultant engineered vent system layout and installation drawings and details that are specific to the project, and include the calculations showing coordination with actual equipment regarding draft requirements and connection requirements.

3.3 Piping shall be assembled with silicone sealant or high temperature cement, as applicable, and inner and outer banding. Horizontal piping shall be suspended from the structure with hanger straps and rods. Systems serving condensing appliances shall be sloped a minimum of .25”/LF per manufacturer’s instructions. Vertical stacks shall be supported by wall and floor supports, as appropriate, and guide assemblies. Free standing stack above the roof shall be guyed to the building structure if not otherwise adequately supported. Minimum clearances from combustible and non-combustible materials required by Code and manufacturer's instructions shall be maintained. The entire installation shall be in accordance with manufacturer's instructions and recommendations, and applicable building codes.

3.4 For roof termination applications, a custom stainless steel welded roof cap shall be fabricated to sit on an insulated roof curb around the flue to allow proper roof flashing. Provide stainless steel roof cap with welded stainless steel rings and turned down edge to allow sealing of the flue and curb . Install mineral wool insulation in the curb to prevent condensation.

END OF SECTION

23 55 34 GAS FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 Gas fired propeller unit heaters shall conform to the requirements as shown on drawings and as hereinafter specified.

1.2 Unit heaters shall have AGA design certification with all electric wiring and controls conforming to applicable requirements of NEC and local codes.

PART 2 - PRODUCTS

2.1 Heaters shall be indirect fired horizontal projection propeller type having corrosion-resistant aluminized steel burner and heat exchanger. Heat exchanger shall have flue gas connection with draft diverter. Burner shall deliver an Efficiency rating of 80% combustion efficiency or higher.

2.2 Fan shall be statically and dynamically balanced with totally enclosed, thermal overload protected motor of voltage indicated on the drawings. Furnish unit with inlet fan guard and adjustable horizontal and vertical deflector blades for complete directional control of air.

2.3 Heater casing shall be draw-formed steel with corrosion-resistant baked-enamel finish.

2.4 Gas train and controls shall be UL/FM compliant, including main gas shutoff valve for low-voltage main gas valve and pressure regulator, pilot shutoff valve, pilot burner with thermocouple and 100 percent safety shutoff, control transformer, limit controls and fan switch. Delivery pressure of gas to the heater regulator (at the inlet of the heater gas train) will be 7 inches w.c. Provide a low pressure kit as necessary for proper burner operation.

2.5 Provide a line voltage heating thermostat for mounting on unit heater inlet.

2.6 Heaters shall be Modine, Reznor or Sterling.

PART 3 - EXECUTION

3.1 Heaters shall be installed in locations shown on the drawings. Hanger rods shall be attached to building roof structure in an owner approved manner with suitable x-bracing furnished in order to prevent sway.

END OF SECTION

23 73 39 DIRECT FUEL FIRED MAKE-UP AIR UNITS

PART 1 - GENERAL

1.1 Each unit shall be a complete factory assembled direct natural gas fired unit designed specifically for tempering of make-up air. Each unit shall consist of a fan section, burner section, filter section, intake cowl, weatherproof housing, unit mounted control panel and a remote control panel. The units shall be roof curb mounted.

1.2 The units shall be factory test-fired and all mechanical, electrical and gas components checked out at the factory.

1.3 Equipment shall carry an all-inclusive manufacturer's parts and labor warranty for a period of one (1) year(s) from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials, equipment, or controls found to be defective during this warranty period shall be made good without expense to the Owner. The warranty shall include a delayed start-up provision such that the warranty does not begin at time of delivery. The labor for the warranty shall be performed by the manufacturer's authorized service agent.

1.4 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 The casing shall be weathertight with galvanized or bonderize prime coated sheet metal panels, continuous welded angle reinforcing, hinged access panels with 0.25 turn latches for access into the fan and burner sections and lifting lugs. The entire casing shall be primed and finished with two coats of baked enamel.

2.2 Fan shall be centrifugal type double inlet with forwardly curved blades discharging thru the floor of the unit. Bearings shall be self-aligning grease lubricated with extended grease lines. Fan drive shall be multiple V belt with belt guard, fixed pulleys and adjustable motor base. The fan and motor shall be mounted on a welded structural steel base and the fan isolated from the base with steel spring vibration isolators. Vibration isolators shall be adequate so as to require no additional isolators for the unit.

2.3 Motor shall be two speed (1800 / 1200 rpm) "premium efficiency" series. Refer to Section 23 05 13 Electrical Requirements for HVAC Equipment. Motor and drive shall be protected in a weatherproof enclosure. Motors connected to VFD's shall comply with 23 05 13 Electrical Requirements for HVAC Equipment and shall be furnished with AEGIS SGR shaft grounding ring kit, installed by the equipment manufacturer.

2.4 Burner shall be natural gas designed for direct firing with a minimum turndown ratio of 20:1. An observation port shall be provided in the section. Gas train shall be a completely pre-piped UL/FM compliant manifold with plug cock, pressure regulator, and all other required safeties. Delivery pressure of gas to the heater regulator (at the inlet of the heater gas train) will be 11 inches w.c. Burner shall not operate unless motorized discharge dampers on the supply fan are open and supply fan is operating. Safeties shall be incorporated to shut the unit down on pilot or main flame failure. Burner shall deliver an Efficiency rating of 92% combustion efficiency or higher.

2.5 Discharge dampers on the supply fan outlet, with electric motor operator having spring return and end switch, shall be provided with each unit. Damper operator shall be designed to operate satisfactorily down to 30 degrees below zero.

2.6 Filter section shall consist of a casing, hinged and latched access panel, filter channels and 2 inches thick aluminum cleanable. Face velocity shall not exceed 500 fpm.

2.7 The inlet cowl shall be fitted with a bird screen and be designed to afford weather protection.

2.8 The unit mounted control panel shall be completely factory wired in a NEMA 3R enclosure containing electrical and control components as follows:

A. Door latch disconnect switch.

B. Two-speed magnetic starter with overload elements on each leg, a high-to-low speed deceleration timer and an auxiliary contact on both high and low speed starter sections.

C. Lugs and fuses on the main power feed.

D. Fused control transformer.

E. Terminal strip for factory installed and field installed wiring.

F. Burner operating and safety controls, including high and low temperature thermostats and cut offs.

G. Discharge air sensor.

H. Mild weather thermostat to not allow burner operation above 65 degrees F.

I. Circuit analyzer with check pilot lights.

The unit shall be completely factory wired requiring a single power feed connection and field installed control wiring between the unit control panel and the remote control panel in the space.

2.9 The remote control panel shall be a NEMA 1 cabinet with hinged and latched door, factory wired to a terminal strip. The panel shall contain:

A. Start stop buttons.

B. High and low fan speed selector switch.

C. Summer winter selector switch.

D. Discharge air controller adjustment dial.

E. Pilot lights indicating discharge damper is open, fan is on and burner circuit is activated.

F. Pilot light indicating burner failure.

G. Switch and pilot light for burner restart.

H. Terminal strip.

2.10 The units shall be Greenheck, Aerovent Type DW, or equal by Hartzell, or Jackson Church.

PART 3 - EXECUTION

3.1 The curb mounted unit shall be furnished with a 12 inches minimum height continuous insulated steel roof curb with integral cant. The curb shall be designed for the slight slope of the roof to ensure leveling of the unit. Flashing and counterflashing shall be provided to afford a watertight and weathertight installation.

3.2 The beam mounted unit shall be set on and secured to the beams.

3.3 Field check out and start up shall be performed by a factory service representative.

END OF SECTION

23 81 28 DX MINI SPLIT SYSTEMS – AIR-COOLED

PART 1 - GENERAL

1.1 The cooling systems shall be variable capacity, DX split heat pump systems. The systems shall consist of indoor fan coil unit(s) matched to outdoor air-cooled condensing unit(s), singularly units on a single outdoor unit, and associated controls. Refer to drawings for capacities and arrangements.

1.2 The design is based on Mitsubishi equipment. The other manufacturers listed in Part 2 are acceptable manufacturers but shall include in their bid price all necessary revisions from the basis of design required to install their system, including but not limited to variations in electrical services, branch controllers, pipe sizing, quantities and arrangements.

1.3 Equipment shall be rated in accordance with ARI 210/240 and so labeled, and shall be Listed by UL or ETL and so labeled.

1.4 The condensing units shall be factory charged with R-410A refrigerant.

1.5 Provide a set of spare filters for each indoor unit.

1.6 The systems shall carry a five (5) year warranty from date of installation. In addition, the compressors shall be covered by the manufacturer's limited warranty for a period of seven (7) years from date of installation. If, during these periods, any part shall fail to function properly due to defects in workmanship or material, it shall be replaced or, at the discretion of the manufacturer, repaired. The 2nd thru 5th year and 2nd thru 7th year warranties do not include labor.

1.7 Refer to the HVAC and Electrical drawings for electrical power feeds. Compare unit requirements to feeder sizes shown. Refer to 23 05 13 Electrical Requirements for HVAC Equipment.

1.8 Installing contractor shall be factory trained and certified to install the systems. Training shall be documented by the manufacturer and certification shall be submitted for review with shop drawings, prior to the installation of the systems.

1.9 Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressure determined in accordance with the building and mechanical code. Refer to specification 23 05 30 Bases and Supports for HVAC Equipment for additional requirements.

PART 2 - PRODUCTS

2.1 Each Air-Cooled Condensing Unit shall consist of:

A. General:

1. Each outdoor unit shall be specifically matched to the corresponding indoor unit size(s), factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll or rotary compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines, individually insulated between the outdoor and indoor units.
2. Accumulator with refrigerant level sensors and controls; high-pressure safety switch, over-current protection and DC bus protection.
3. High efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

4. Auto-charging feature and a refrigerant charge check function. The unit shall be capable of metering the refrigerant charge as additional refrigerant is added to the system and will calculate how much additional refrigerant is to be added to the system.
5. Oil recovery cycle shall be automatic occurring after start of operation and then at re-occurring intervals during unit operation.
6. Cooling operation down to 0 degF dry bulb ambient temperature. Provide accessories as necessary to achieve the low ambient operation.
7. The system shall automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for re-programming.
8. Unit shall have a sound rating no higher than 55 dB(A) measured at 3 feet from any side of the unit.

B. Cabinet shall be fabricated of galvanized or rust-proofed steel, bonderized and finished with a powder coated baked enamel. The outdoor unit shall come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to an equipment rails.

C. Condenser fans shall be statically and dynamically balanced direct drive, variable speed propeller type. Fan motor shall have inherent protection, permanently lubricated bearings, and be completely variable speed. Fan motor shall be mounted for quiet operation. Fan shall be provided with a raised guard to prevent contact with moving parts.

D. Condenser coils shall be copper or other nonferrous construction with corrugated fin tube. The fins shall be aluminum or covered with an anti-corrosion acrylic resin and hydrophilic, rated for up to 500 hours salt spray. Automatic defrost shall remove any frost from the outdoor unit allowing the system to maintain heating capacity.

E. Compressor

1. Compressors shall be inverter scroll or rotary type, inverter-driven variable speed, capable of changing the speed to follow the variations in total cooling and heating load.
2. Each compressor shall be equipped with a crankcase heater (if required for specified design and operating conditions), high pressure safety switch, and internal thermal overload protector.
3. The capacity control range shall be minimum 10% to 100%.
4. Compressor assembly shall be installed on vibration isolators.
5. The following safety devices shall be included on the condensing unit: high pressure switch, control circuit fuses, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

F. Units shall be rated under AHRI 210/240 and 340/360. Single-Phase units shall meet or exceed the DOE requirement of 19 SEER and 14 HSPF.

Note: Shop drawing submittals shall include AHRI ratings to show compliance with the requirements.

2.2 Fan Coil Units

A. Wall Mounted Units

1. General
   a. Wall mounted units shall be completely factory assembled and tested. Included in the unit shall be factory wiring with on/off switch, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, time delay fusing, and test run

switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The local controller shall be able to adjust the discharge angle.

b. A mildew-proof, polystyrene air filter and condensate drain pan shall be included. The indoor units sound pressure shall be no more than 50 dB(A) at high speed measured at 3.3 feet from the unit.

c. Refer to drawings for required capacities.

2. Cabinet shall be zinc-coated bonderized steel finished with a baked enamel paint. Inlet grilles shall be attractively styled, high-impact polystyrene. Matching mounting brackets shall be provided.

3. Fans

a. Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.

b. Horizontal and vertical air sweep operations shall be user selectable.

c. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.

4. Coil shall be a 2-row copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. The drain pipe shall be able to be fitted from either left or right sides.

5. Electrical Requirements

a. Unit shall operate on 115 volt, 208 volt, or 230 volt, 60 Hz single-phase power supply as specified on the equipment schedule. Power and control connections shall have terminal block connections.

6. Controls

a. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The space temperature control range shall be from 64F to 84F.

b. Provide hard wired wall-mounted local programmable controller with integral space sensor for each unit, with features as specified in the “Controllers” paragraph below.

c. Controls shall be 24 volt, and shall be easily operated by the user from the wall-mounted local controller.

7. Accessories

a. Condensate Overflow Switch -- A level sensor on the condensate pan shall stop cooling operation and alarm the BAS if the level in the condensate pan is near overflow condition.

b. Condensate Pump – Provide a factory-furnished UL 2043 plenum-rated condensate pump and sensing unit compatible with the fan coil voltage to remove condensate from the drain pan. Pump shall be thermally-protected (auto reset) and designed for quiet operation (less than 27 dBA) and consist of two parts: a reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be minimum 36”. Pump shall be powered and wired from the fan coil unit power connection, downstream of safeties.

2.3 Controllers:

A. Local Controllers (Room Thermostats)

1. Wall mounted local remote controllers (thermostats) shall be provided to allow the user to change on/off, temperature setting, and fan speed setting for each fan coil unit. The room temperature shall be sensed at this wall mounted remote controller (thermostat) unless noted otherwise. The controller shall display a four-digit error code in the event of system abnormality/error.

2. The Local Controller shall be mounted into a standard 2” x 4” junction box.
3. Unit Display
   a. The Local Remote Controller shall be a backlit LCD display with contrast adjustment.
   b. The controller shall display On/Off Status, Operation Mode, Setpoint, and Fan Speed. The controller shall display temperature setpoint in one degree increments with a range of 60-90 degF. On/Off status shall be displayed with an LED.
   c. Error codes shall be displayed in the event of system abnormality/error.
   d. The following system temperatures shall be capable of being displayed to assist service personnel in troubleshooting:
      1) Return air temperature
      2) Liquid line temperature
      3) Gas line temperature
      4) Discharge air temperature (if available on the unit)
      5) Remote temperature sensor temperature (if applicable)
      6) Indoor space temperature setpoint
4. Operation
   a. The following operation groups shall be controlled:
      1) On/Off, Operation Mode (Cool, Heat, Fan, Dry and Auto*)
      2) Independent cooling and heating setpoints in the occupied mode
      3) Independent cooling setup and heating setback
      4) Fan speed
      5) Airflow direction
      6) The controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating in the occupied period
      7) Lock out key settings
5. Program Functions
   a. Controller shall support schedule settings with selectable weekly pattern options.
      1) Seven day week
      2) Weekday + weekend
      3) Weekday + Saturday + Sunday
      4) Independently settable Cooling and/or Heating setpoints when unit is on (occupied).
      5) Setup (Cooling) and Setback (Heating) setpoints when unit is off (unoccupied)
      6) A maximum of 5 operations schedulable per day
      7) Time setting in 1-minute increments.
   b. The Controller shall support auto-changeover allowing the optimal room temperature to be maintained by automatically switching the indoor unit’s mode between Cool and Heat according to the room temperature and temperature setpoint.
      1) Changeover to cooling mode shall occur at cooling setpoint + 1oF .
      2) Changeover to heating mode shall occur at heating setpoint - 1oF .
   c. The Controller shall support an Auto-Off-Timer for temporarily enabling indoor unit operation during the unoccupied period.
      1) When the Off Timer is enabled and when the unit is manually turned on at the remote controller, the controller shall shut off the unit after a set time period.
      2) The time period shall be configurable in the controller menu with a range of 30-180 minutes in 10 minute increments.
   d. The space temperature shall be sensed at the local controller.

2.4 Refrigerant Piping:

A. Refrigerant piping shall be copper tubing conforming to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition.

B. Copper tubing shall be Type ACR, hard-drawn straight lengths. Fittings shall be copper, UL or ETL tested to UL 207, and certified to a working pressure of 600 psig. All joints shall be brazed using silver brazing alloy while flowing an inert gas such as dry nitrogen through the piping. Copper tubing that is .625" size and smaller may be Type ACR soft annealed coils for lengths under 25 ft if approved by the equipment manufacturer. Refer to 23 23 00 for additional information.

C. Pipe arrangement, devices and sizing information shown on the drawings is limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Drawings shall be submitted to the Engineer for review with the equipment shop drawings.

D. The equipment supplier shall provide piping installation instructions to the Contractor and supervision as needed to ensure that the piping system is installed in accordance with the equipment manufacturer's recommendations.

E. Units shall be manufactured by Mitsubishi, Carrier, Daikin, Trane.

PART 3 - EXECUTION

3.1 Installers shall have received training by the manufacturer of the systems being supplied for the project. If they have not received training the system manufacturer shall schedule and perform required installation training.

3.2 Piping Installation

A. Pipe arrangement, devices and sizing information shown on the drawings is schematic in nature, limited due to variations in equipment manufacturers' requirements. The equipment supplier shall prepare project-specific drawings of each piping system showing numbers and sizes of piping, devices and accessories, coil circuitry, traps, double suction risers and other such detail required for the application shown on the drawings and as specified herein. Exact routing, and pipe quantities and sizing shall be per manufacturer's requirements. Refrigerant piping shall conform to ANSI B31.5 and ASTM B280. Refrigerant piping systems and components shall be engineered, installed, tested and placed in operation in accordance with ASME B31.5, latest edition. Drawings shall be submitted to the Engineer for review with the equipment shop drawings. Exact routing, and pipe quantities and sizing shall be per manufacturer's requirements.

B. At time of equipment submittal approval a piping diagram shall be provided by the equipment manufacturer to the Installing Contractor for each split system. The equipment manufacturer shall review the piping diagram with the Installing Contractor.

C. A copy of the Approved piping diagrams shall be kept at the jobsite.

D. The Installing Contractor shall update the piping diagrams with any field changes such as re-routing, shortening, lengthening or changing diameter of a pipe segment, adding or eliminating elbows and or fittings, resizing adding or eliminating indoor units, changing the mounting height, or moving the location of a device or fitting during installation. Those changes shall be communicated to the equipment manufacturer PRIOR TO INSTALLATION. The equipment manufacturer shall review and provide written approval or required modifications prior to installation.

E. The equipment manufacturer shall update their Piping Program to an “As-Built” program. Proper refrigerant charge shall be calculated and communicated to the Commissioning/Startup Technician along with the As-Built piping program.

F. The equipment manufacturer’s representative shall inspect the piping system prior to charging and start-up, and document their approval or required changes.

G. System shall be leak checked, evacuated and charged by the Installing Contractor. Refer to 23 23 00.

3.3 Control wiring shall be installed between indoor units, condensing units, in strict accordance with the manufacturer’s instructions. All control wiring shall be low-voltage plenum rated type.

3.4 Furnish and install all controls, wiring and accessories for a complete and operational system. Coordinate control integration into the BAS with the BAS installer.

3.5 Locate equipment so as to afford adequate service space.

3.6 Outdoor condensing units shall be installed in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Set with Type C2 isolators and secure to equipment rails on roof. Piping shall be connected utilizing flexible connectors.

3.7 Install fan coil units in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. For gravity drained units, provide a drain pipe with trap from fan coil drain pans and extend piping to a floor drain or other point of discharge as shown and terminated per the Code. For fan coils fitted with condensate pumps, install pump and sensing devices in evaporator condensate drain piping, and provide and/or extend power and control and safety wiring, all in strict accordance with the manufacturer’s instructions. Condensate piping shall be extended to a floor drain or other point of discharge as shown and terminated per the Code.

3.8 Roof mounted condensing units shall be installed a minimum of 10’-0” from any roof edge not protected with a code compliant guard rail regardless of location indicated on plans. Units shall be installed in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Set with Type C2 isolators and secured to roof equipment rails attached to the roof deck and flashed into the roofing system. All bases and curbs for roof mounted equipment shall be constructed and attached to the roof deck such that installed equipment can withstand a minimum of 186 mph wind loads. Piping shall be connected utilizing flexible connectors.

3.9 Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

3.10 The system shall be checked, started, tested, adjusted and commissioned by a factory trained service agent of the manufacturer prior to operation. The unit manufacturer will be responsible for the start-up, programming, and commissioning of the entire variable refrigerant volume system. This shall include coordinating the interface requirements and system points with the temperature controls contractor. Manufacturer shall test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

3.11 Provide services of manufacturer's technical representative for 1 days to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner.

3.12 In addition to the adjustments and fine tuning, the Contractor shall include as a part of this contract the equivalent of one (1) man days of service technician time for work as may be specified by the Engineer.

3.13 The control equipment supplier shall provide 4 hours of instruction and training of the Owner's personnel regarding the hardware and software of the system. Software training shall include programs, methods of programming, control loops, scheduling and reports. Site training classes shall not be scheduled for longer than 4 hours duration except at the discretion of the Owner. Contractor shall videotape the demonstrations and make copies available to the Owner.

END OF SECTION

23 82 39 ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 Unit heaters shall be electric cabinet type units. Refer to the drawings for arrangement, type, capacity, motor characteristics and other requirements.

1.2 Provide electric components of terminal units which have been listed and labeled by UL.

PART 2 - PRODUCTS

2.1 Electric cabinet unit heaters shall consist of:

A. Direct driven centrifugal fans in a blow thru arrangement with multi speed permanent split capacitor motor having internal overload protection. A fan speed switch with "off" position shall be mounted behind a hinged access door and factory wired.

B. Heating coil shall be finned steel sheaths helically wound, individually removable, with corrosion resistant finish.

C. Electrical power and control devices shall be factory mounted and wired in a compartment within the unit enclosure, and factory tested. Devices shall include a terminal block, dead front disconnect switch, contactors, high temperature limit switch, fan limit switch, transformer for controls, transformer for fan motor if voltage is not compatible with service feed, fuses and other devices to complete the package.

D. Thermostat to cycle the fan and coil on a call for heat shall be integral with floor or wall units. A wall mounted thermostat shall be provided with each unit mounted at or above the ceiling.

E. Cabinets of exposed heaters shall be constructed of bonderized steel, 16 gauge front and 20 gauge back and sides, with outlet grille and inlet grille as appropriate. Recessed units shall have overlapping cabinet or wall flange on all four sides. Concealed units shall have a discharge duct collar and where return ductwork is required, a return duct collar. Exposed cabinets shall be finished with baked enamel of colors selected by the Architect from the manufacturer's standard decorator colors. Exposed and recessed cabinets shall have a lockable access door.

F. Electric cabinet unit heaters shall be manufactured by TPI Corporation (Ray-Wall, Markel, or Redd-i), Trane, or Q-Mark/Chromalox.

PART 3 - EXECUTION

3.1 Suspended units shall be hung from the building structure with steel hanger rods and auxiliary angles and fastening devices.

3.2 Provide all required wiring between the unit and wall mounted thermostats, in conduit per Division 26 and the N.E.C..

END OF SECTION

26 05 01 BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 Special Note

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.

B. The scope of the Division 26 work includes furnishing, installing, testing and warranty of all Division 26 work and complete systems as shown on the Division 26 drawings and as specified in Division 26 and elsewhere in the project documents.

C. Understanding that the contractors for various Divisions are sub-contractors to the Construction Manager at Risk, assignments of work by division are not intended to restrict the Construction Manager at Risk in assignment of work among the contractors to accommodate trade agreements and practices or the normal conduct of the construction work. If there is a conflict of assigned work between Divisions 02 thru 33 and Divisions 00 and 01, Divisions 00 and 01 shall take precedence.

1.2 Alternates

A. Alternate 02 ADD ALTERNATE

The base bid work does not include a lightning protection system. Each bidder is requested to state the addition in cost to provide all Electrical work for adding lightning protections system to the bus garage roof and bus wash roof.

1.3 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the work in this Division. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

1.4 Inspection of Site

A. Inspect the project site and the premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect / Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.5 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used, shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect / Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect / Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having bus duct, wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install bus duct, wireways, fittings and equipment.

D. The Architect / Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where they consider such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork and piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces about Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance to Enclosures and Access to Work Space – 110.34 Work Space and Guarding. Caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's / Construction Manager's decision shall be final in regard to the arrangement of bus duct, conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect / Construction Manager. In such event, none of the trades or their suppliers shall assume that they are relieved of the work which is specified under their branch until instructions in writing are received from the Architect / Construction Manager.

1.6 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 26 Contract. Necessary work of this nature will be arranged by the Owner / Construction Manager to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect / Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.7 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.8 Record Drawings

A. Maintain a separate set of field prints of the contract documents and hand mark all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work and within 90 days of system acceptance, these hand marked drawings shall be turned over to the Architect / Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.9 Operating and Maintenance Manuals

A. Assemble electronic copies each of operating and maintenance manuals for the Electrical work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required. Name and address of a qualified service agency. A complete narrative of how each system is intended to operate. Major items of equipment shall consist of not less than the following:

1. Distribution switchgear and switchboards.
2. Emergency generator and load transfer equipment.
3. Motor controllers and motor control centers.
4. Specialty equipment.
5. Fire alarm, communications and sound systems.
6. UPS Systems.
7. Lighting equipment and lighting controls.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number; date of purchase; name, address, and phone number of the vendor; warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and Construction Manager for review. Upon approval and within 90 days of system acceptance, manuals shall be turned over to the Owner.

1.10 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 26 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect / Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.11 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Use of equipment for temporary electric is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to, motor controller malfunction, heater element changes required for motor controller, fuse replacement where fuses blow due to abnormal shorts, adjustments and/or replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 Reference Standards

A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

2.3 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name

is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will only be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

D. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.4 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured. Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Shop drawings of the following equipment and materials shall be submitted:

1. Wireway.
2. Cable trays and firestopping.
3. Manholes and pull boxes.
4. Miscellaneous cabinets.
5. Wiring devices and coverplates.
6. Distribution switchboard.
7. Overcurrent protective device coordination study.
8. Secondary metering enclosure.
9. Secondary termination cabinet.
10. Surge suppression.

11. Dry type transformer secondary.
12. Panelboards.
13. Cabinets and enclosures.
14. Fuses.
15. Motor controllers, control centers and disconnects.
16. Automatic transfer switch.
17. Lighting fixtures.
18. Lighting standards.
19. Lighting controls/contactor and photocell.
20. Emergency generator and accessories.
21. Lightning protection.
22. Fire alarm system.
23. Security system.
24. Sound system.
25. Telephone equipment and system.

PART 3 - EXECUTION

3.1 Testing

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. On all electric services including change-outs, backfeeds, etc. the Contractor shall verify phase rotation and voltage readings to ensure the final installation is proper. Submit to the Engineer in writing a record of voltage readings and current readings taken at no-load and fully loaded conditions.

D. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

E. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Submit four (4) copies of reports indicating results.

F. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

G. Instruments required for tests shall be furnished by the Contractor.

3.2 Equipment Cleaning

A. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be performed in accordance with equipment manufacturer's recommendations.

B. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents;

verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

B. Caution: Verify that all bearings of equipment furnished are lubricated, all motors are operating in the right direction, and correct drive settings and overload heater elements are provided on all motors. Do not depend wholly on the other trades judgment in these matters. Follow specific instructions in regard to lubrication of equipment furnished under this Contract.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect / Engineer / Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

D. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

END OF SECTION

26 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at their sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in a .DWG or .RVT format as indicated in the Agreement and Waiver Form. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to the contractor's systems.

1.7 All drawings will be in an AutoCAD file format, when requested to be .DWG format.

1.8 All project models will be furnished without views.

1.9 All electronic files shall be stripped of the Project's name and address, the Architect's and Engineer's and any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data,

information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

ELECTRONIC FILES
HEAPY RELEASE FORM TO CONTRACTORS

Project: GDRTA Paratransit Bus Garage
701 Longworth Street
Dayton, OH

Owner: Montgomery County

Heapy Engineering Project Number: 2023-07202

Heapy Engineering Project Manager: Don Timmer

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter collectively referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider's Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of the Agreement and Waiver for Use of Electronic Files).

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

    b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

    c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

    a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

    d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management

site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Development (LOD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Recipient Address: _____

    Name of authorized Recipient Representative: _____

    Title of authorized Recipient Representative: _____

    E-mail address of authorized Recipient Representative: _____

    Signature of authorized Recipient Representative: _____

    Date: _____

NOTE: Select requested Electronic File Format, File Transfer Medium and complete applicable Summary.

A. Electronic File Format (select one):

1. ☐ .DWG Format - List of Drawings Requested: _____

_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

B. File Transfer Medium (select one):

☐ CD-ROM ☐ DVD-ROM ☐ Heapy FTP ☐ User's FTP site ☐ Flash Drive

C. Delivery of Electronic Files Summary:

Available Electronic .DWG file format:
☐ 20XX DWG

If a different file version is required than the indicated available version state the requested version:

_____ .DWG

All files will be bound together.

Available electronic Revit file format:
☐ 2023 .RVT

26 05 04 BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Temporary Electric Services

A. The temporary service and temporary lighting for construction is provided by the Contractor. Refer to Division 01 - General Requirements.

B. The Contractor is cautioned to carefully consider the possible sources of temporary electric service and the probable location of the General Contractor's office.

C. The General Contractor will make application to the local utility company for the temporary electric service and will pay for all electric power used during construction, including electric heating.

D. The Contractor shall furnish, install and pay for all necessary conduit, wire, metering, poles, switches, receptacles, lights and accessories to provide a 400 amp, 120/208 volt, 3 phase, 4 wire temporary electric service with the main disconnect switch, meter, and a 42 circuit load center at a location specified by the General Contractor.

E. Consult the utility company for fees required and include same in Electrical Contract.

F. Labor, receptacles, boxes, fixtures, wire, etc. required by the various Contractors inside their offices shall be paid for by the respective Contractors.

G. Lighting fixtures shall be placed every 40 ft. along each corridor or, where corridors do not occur, along the long axis of all rooms and areas greater than 25 ft. in length. Provide a 200 watt (or LED equivalent) lamp in a rubber coated socket with wire guard, spliced into branch feeder conductor at every 20 ft. The branch circuit wiring may be 3 wire type "NMC" and the wire guard shall be bonded to the ground conductor. Receptacle circuits shall consist of 1 gang handy box with grounded duplex receptacles a maximum of 50 ft. on center with a maximum of 4 per circuit. All receptacle circuits shall be protected by its own overcurrent device in a panelboard. Install wiring and equipment above 6 feet 6 inches and below the finished ceiling. Extend circuits as required and protect in an appropriate panelboard on each floor level. Provide GFCI protected receptacles and circuits as required by NEC and OSHA.

H. Contractors requiring extension cords shall provide their own cords and plugs up to capacity of 20 amperes. For services to larger items of equipment and welders, this Contractor shall extend proper feeders as requested at the expense of the Contractors requiring the service.

I. The Contractor shall maintain the temporary light and power system for the duration of the work and shall remove it from the site when directed or no longer required as coordinated with the construction team. Temporary wiring and equipment shall remain the property of the Contractor.

J. The use of the permanent electrical system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.

K. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.

L. The complete temporary service shall comply with Power Company, OSHA, and all Code requirements.

1.2 Continuity of Service

A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark up.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed junction boxes, valves, traps, devices and equipment requiring service or adjustment.

B. Access panels shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with screwdriver lock. Locks in “secured” areas of the building shall have tamperproof screws. Panels shall be 18 inches x 18 inches size unless larger panels are shown or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls, Milcor Style “M” or equal.

2. Standard flush type for drywall ceilings and walls, Milcor Style “M” or equal.

C. Access panels in drywall ceilings shall be glass reinforced gypsum drywall lay-in panels with flush mounting frames. Corners of panels shall be rounded. Panels shall be 18 inches x 18 inches unless larger panels are shown or required. Panels shall be equal to Chicago Metallic Model CRG.

D. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

E. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all

respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Electrical work shall be performed by a licensed Contractor in accordance with requirements of the jurisdiction.

3.2 Protection

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with their work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect, or Construction Manager.

3.3 Cutting and Patching

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where conduits, cable trays, bus ducts and wireways are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, sawcut or core drill holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect or Construction Manager. Any damage caused to the building in this work shall be repaired or rectified.

C. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

3.4 Painting

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 26:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite cold galvanizing compound, or approved equal, for touch-up and repair of previously galvanized surfaces.
5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.

B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.

C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.5 Access Panels

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Access locations thru HVAC ductwork must be coordinated with the ductwork installer. Location of the hinged access door with latch must be coordinated in advance with the HVAC Contractor.

C. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

D. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

3.6 Backboards

A. Where shown on the drawings, backboards shall be provided for wall mounting of disconnect switches, devices and communications equipment. The Contractor may opt to mount additional groups of disconnect switches on backboards.

B. General

1. Backboard shall be 0.75 inch thick waterproof flame retardant plywood secured to structure.

2. Each board shall be painted.

3. Telephone backboards shall be normally 4 ft. x 8 ft. mounted 6 inches above floor where located on drawings. Where other sizes are required, they will be noted on the drawings.

C. Each terminal cabinet for communication systems, relays, etc., shall be fitted with a full size 0.50 inch thick backboard for mounting terminal strips, equipment, etc.

END OF SECTION

26 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of conduits, bus ducts, cables, cable trays and other electrical items thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions and smoke barriers. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements.

1.2 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with ANSI / UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.3 Firestopping materials, assemblies and installation shall conform to requirements of the OBC / Chapter 1, Section 106 and Chapter 7, Section 714 / and the Authority Having Jurisdiction.

1.4 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests shall be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.5 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required in OBC Chapter 1, Section 106 and Chapter 7, Section 714.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Tremco, or Specified Technologies Inc (STI).

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and firestopping assemblies shall be equal to Hilti CP 680.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

3.3 Refer to 26 05 33 Raceway and Boxes for Electrical Systems for sleeve requirements and treatment of penetrations not requiring firestopping.

END OF SECTION

26 05 09 EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 Excavate for all in-grade underfloor conduit, exterior ducts, conductors, conduit, lighting standard bases, underground tanks and incidental work which are included in the Electrical contract. Backfill to finish grade or to levels consistent with the General Contractor's and the Site Contractor's activities. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition where such are not affected by Division 31 – Earthwork or Division 32 Exterior Improvements. Cut existing floor slabs and replace slabs in conformance with 26 05 04 Basic Electrical Materials and Methods. All work shall comply with requirements set forth in Division 31 and 32.

1.2 Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in the contract.

1.3 Contact the Ohio Utilities Protection Service 8-1-1 or (1 800 362 2764) / and the Oil and Gas Producers Underground Protection Service (1-800-925-0988) sufficiently in advance of the start of any excavation so that notification can be made to member utility departments and utility companies (water, sewer, gas, petroleum, electric, telephone, cable, etc.) having underground utilities in or near the project area. Also contact those companies to verify that utility lines have been located and duly marked and identified.

1.4 A utility locator service shall be engaged to locate, mark and identify private lines and other utilities that are not located by the means mentioned above.

1.5 Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by this Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 Refer to Division 31, Earthwork for bedding and backfill materials specifications.

PART 3 - EXECUTION

3.1 Interior and exterior trenches shall be over excavated and the duct, conductor or conduit shall be laid on 4 inches minimum depth sand bed. Where ductbank is concrete encased, excavate to required depth, if fill or backfill needed under ductbank use washed pea gravel or crushed limestone and compact.

3.2 Backfilling of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with graded pea gravel, graded coarse sand or crushed limestone 0.75 inch maximum size, to prevent undue settlement. Backfill material for non-metallic conduit shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials or with excavated material up to 18 inches above the top of the conduit. The remainder shall be with similar materials or with excavated material having no large clots, stones or rocks.

3.3 Backfill shall be mechanically compacted in layers not over 6 inches deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of as directed by the General Contractor. Refer to Division 31 Earthwork for compaction requirements.

3.4 Fuel storage tanks shall be backfilled in accordance with tank manufacturer's instructions. The tank shall be set on a 12 inch deep bed (between the bottom of tank and the top of the concrete anchor pad or, if no pad, the bottom of the excavation) of washed pea gravel, 0.125 inch to 0.75 inch diameter. Backfill around and immediately above the tank shall also be pea gravel.

3.5 Concrete floor slabs, paving, sidewalks, curbs, sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced by this Contractor equal to original conditions. Refer to Division 31 and 32 for Surface Restoration Requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.

3.6 Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadway shall be included in this contract so that no additional cost will accrue to the Owner.

3.7 Maintain in place adequate barricades, guards, planking, plating, signage, warning lights, etc., at and around excavations.

3.8 All exterior underground conduit, concrete encased ducts, and direct buried conductors shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6 inches wide with black letters identifying the type of service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18 inches above and on the centerline of the conduit, duct or conductor.

END OF SECTION

26 05 19 A LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS COPPER

PART 1 - GENERAL

1.1 This section pertains to the use of copper conductors, 600V insulation class.

PART 2 - PRODUCTS

2.1 All conductors shall be copper: conductors shall be insulated for 600 volts.

2.2 Insulation types referenced are those of NEC. All conductors shall be UL labeled and shall be marked for size and type at regular intervals on its length. Conductors #8 and larger shall be stranded; #10 and smaller may be stranded provided approved terminations are used.

2.3 Types of conductor insulation for general use may be any of the following, subject to limitations listed, in addition to those in the NEC:

A. Type THHN - restrictions - do not use for conductors in slab. Do not use in wet locations.

B. Type THWN - no restrictions.

C. Type XHHW - no restrictions.

2.4 Use shielded VFD cables for feeds from VFD to motor where conductor length is longer than 25 feet. VFD cable shall be 3 conductor XHHW low capacitance copper, full size insulated copper ground, 1.5 mil AL foil and 85 percent tinned copper woven braid shield with PVC oil and sunlight resistant jacket. UL TC-ER, 90 degrees C., 600V wet/dry. Manufactured by Belden, AWC, Lutze or equal.

2.5 Use only Type XHHW for isolated ungrounded branch circuit wiring such as monitored wiring in hospital operating and special procedures and X ray rooms. Refer to Section "Hospital Specialty Equipment".

2.6 Use Type THHN or XHHW, (90 degrees C. rated) types for connecting luminaires and for running thru fixture housings.

2.7 Use conductors such as type FEP with high temperature insulation as identified in the NEC for connections to resistance heating elements or in other areas subject to temperature exceeding the rating of THWN, XHHW or THHN.

2.8 Color Coding – The use of colored commercial building wire is encouraged.

A. On 208/120 volt, three phase and 240/120 volt, single phase grounded systems, wires colored black, red and blue shall be used for phase conductors. Neutral wires on these systems shall be white. If conductors No. 4 AWG or larger are not available in white or white stripes, the neutral may be a black wire identified with white tape, minimum size 0.50 inch wrapped twice around at the following points:

1. At each terminal.
2. At each conduit entrance.
3. At intervals not more than 12 inches apart in all accessible enclosures.

B. On 480/277 volt, three phase system, wires colored brown, orange and yellow shall be used for phase conductors. Neutral wires on these systems shall be gray or other NEC acceptable means for distinguishing each system grounded conductor from another. If conductors No. 4 AWG or larger are not available in the proper colors, black wire may be used with 0.50 inch tape bands of the proper color at the following points:

1. At each terminal.
2. At each conduit entrance.
3. At intervals not more than 12 inches apart in all accessible enclosures.

C. Equipment grounding conductors shall be green, or for 4 AWG and larger may be completely taped green, at all accessible points.

D. All control circuits shall be red with individual wire identification on each conductor.

E. Where existing wiring systems (remodel work or building additions) have different color coding, consult the Engineer concerning matching existing wire color coding and phasing.

2.9 Wire size ampacity shall equal or exceed its overload protective device. Where wire sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by N.E.C. Minimum conductor size shall be No. 12 AWG except No. 14 AWG may be used only for control wiring or where otherwise specifically shown.

2.10 When necessary to use a lubricant for pulling wires, lubricant must be listed by Underwriters' Laboratories, Inc. Only cable lubricants approved for the type of jacket material or insulation shall be used, and must be of such consistency that it will dry completely when exposed to air. Lubricant must leave no obstruction or tackiness that will prevent pulling out old wires or pulling in new wires or additional wires, and, after drying, must leave a film of lubrication which will promote easy movement of the wires. The lubricant shall contain no waxes, greases, silicones, or polyalkylene glycol oils or waxes. Lubricant shall be Ideal "Yellow 190", 3M “WL”” Wire Pulling Lubricant, or approved equal.

2.11 Splices No. 10 AWG and smaller shall be made using the following:

A. Preinsulated spring pressure connectors as follows: ITT Holub "Freespring", with metal grip threads 3M "Scotch-Lok", Ideal "Wingnut", Thomas and Betts Type "PT", or Buchanan "B Cap". Other hard insulated wire connectors which have bakelite or ceramic insulation are prohibited. (Non-metallic thread connectors shall not be used.)

2.12 Splices No. 8 AWG and larger shall be made using the following:

A. Approved crimp type connectors with special crimping tool; T&B, Burndy, Buchanan or approved equal. Joints and free ends shall be covered with tape or approved moistureproof insulating kits. Applied insulation shall exceed 150 percent of conductor insulation voltage rating.

B. For two or more taps use Power Distribution Blocks by Square D, Gould, Taylor, Ilsco or Connectron.

2.13 Wiring in vertical raceways shall be supported with strain relief devices; Kellem's grips or approved equal.

2.14 Connections to equipment shall be made with pressure type terminals. On stranded wire, use spade type terminals or terminals approved for use with stranded wire. Connections shall contain only single conductors unless approved for multiples.

A. For conductors No. 10 AWG and smaller, applied crimp type terminals shall be T&B "Sta Kon" or approved equal.

B. For No. 8 AWG and larger conductors, applied crimp type terminals shall be Burndy, T&B or approved equal.

2.15 Direct buried underground cable, where shown on drawings, shall be direct buried type rated 75 degrees C. Cable shall be multi-conductor, copper with a separate ground conductor sized per N.E.C. 250 122. Install in a PVC sleeve under all walkways and drives.

2.16 Where tape is applied over wires and connectors on 600 volt or lower voltage applications, it shall consist of a minimum of two (2) half lapped layers of Scotch "88" or Plymouth No. 4240 for both indoor and outdoor applications, except Scotch 33 Plus or Plymouth No. 4453 is acceptable for use indoors.

2.17 Where fireproofing of cables is noted on the drawings or required by Code, each cable shall be arc and fireproofed with one (1) half lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape. Tape shall be secured with a 2 layer band of Scotch Brand 69 Glass Electrical Tape over the last wrap. Installation shall comply with manufacturer's recommendation.

2.18 Where installed underground, splices and terminations shall be listed and approved for waterproof application. Utilize kits approved for the application.

PART 3 - EXECUTION

3.1 Branch circuit conductor identification means shall be permanently posted at each panelboard and switchboard. This identification shall be installed on the inside of the door and shall identify conductor colors for each voltage system in the building. Provide identification at all new panelboards and existing panelboards utilized within this project.

3.2 Conduit systems shall be clear and clean before pulling wire. Branch circuit conductors shall be pulled without resorting to levers or heavy pulling devices.

3.3 Cable pulling tensions shall not exceed recommended values.

3.4 Group ungrounded and grounded circuit conductors for each multiwire branch circuit by cable ties in panelboards and tap boxes.

3.5 Each branch circuit or multiwire branch circuit shall have its own dedicated neutral. Group neutral conductors with phase conductors by wire ties in each enclosure where multiple neutrals provided.

3.6 Shielded VFD cables shall be provided for VFD to motor conductors length longer than 25 feet. VFD motor feed cables shall be terminated per VFD manufacturer’s direction.

3.7 Control conductors shall not be run in same raceway with branch circuit or motor circuit conductors.

3.8 Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only, ground conductors are not counted when determining maximum fill for this purpose.

3.9 Wire tags shall be provided on all main and feeder conductors in all pull boxes, wireways and panelboard and switchboard wiring gutters. Tags shall identify wire or cable number and/or equipment served. Tags shall be of flame resisting adhesive material, T&B Type WSL or approved equal.

3.10 Perform meggar tests on all feeders and motor branch circuit conductors prior to energization of circuits. Provide documentation in standard NETA format to the Engineer for review. Do not run meggar check on solid state equipment.

END OF SECTION

26 05 19 B LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS - ALUMINUM

PART 1 - GENERAL

1.1 This section covers the use of aluminum conductors 600 V insulation class, in lieu of copper in certain limited instances as approved by the Engineer and Owner. Refer to Section "Conductors Copper" for color coding, tagging and basic installation requirements.

1.2 This section is applicable for feeders only in substitution for copper conductors in copper sizes #1/0 and larger. The use of aluminum conductors shall be limited to feeders. All feeder grounding conductors and bonding conductors shall be copper.

1.3 Conductor sizes shown on the drawings are based on copper. Ampacity of aluminum conductors shall equal or exceed those of the copper sizes shown.

1.4 The use of aluminum conductors entails larger conduit, gutters, boxes and wireways to meet code requirements. These enlarged sizes shall be a consideration in the application of aluminum conductors under this section.

PART 2 - PRODUCTS

2.1 Aluminum conductors shall be stranded, 600 volt, with type THWN, THHN or XHHW insulation. Sizes shall be limited to ampacity of #1/0 copper and larger.

2.2 Oxide inhibiting paste - Burndy "Penetrox", Kearny "Kearnelex" or Ilsco "DE OX".

2.3 Connectors shall be long barrel compression type with minimum of two compressions per lug, one or two hole type as required, using appropriate dies and tools of size and type recommended by the manufacturer. Connectors by Burndy, T&B or Ilsco.

2.4 Where compression spade type terminals cannot be used, a compression termination to a "pigtail" of tinned copper shall be used; the copper "pigtail" can then be terminated in screw type terminals.

2.5 On conductors 500 Kcmil and larger, two hole crimp type lugs shall be used. Bolts shall be aluminum alloy 2024 T4 with compatible aluminum alloy nuts and washers. Where steel bolts are used, spring washers and heavy flat washers shall be used. Aluminum bolts shall be heavy shoulder shear type with National Standard coarse thread.

2.6 Connectors shall be submitted for approval before installation proceeds. Submittal shall include catalog numbers for each wire size and recommended tools and dies.

PART 3 - EXECUTION

3.1 Installation

A. All terminations shall be made with crimp compression connectors UL approved for the application, factory filled with inhibitor anti oxide paste; connectors shall be attached using a hydraulic press and dies. Set screw type connectors are not acceptable.

B. Aluminum conductors shall be prepared for connection.

1. Strip insulation with penciling tool - do not ring conductor with knife.
2. Remove oxide film with brush.
3. Note that an oxide film forms immediately on an aluminum surface after cleaning; therefore, it must be inserted into the inhibitor filled connector immediately after being brushed.

C. Clean the external connector face of the terminal pad after connection to the conductor, and coat with inhibitor paste before clamping to other pads or flat bars; this procedure applies also to surfaces on flat bars. Scratching must be omitted on flat tin plated surfaces; however, clean such surfaces with an etching type alkaline solvent cleaner.

D. For bolted connections between dissimilar metals, such as copper bus bars in panelboards and aluminum connector pads, use Belleville spring washers and plated heavy flat washers, one pair each side.

E. Use cast aluminum "slips" or terminal stacking adapters for connection of more than 4 lugs to a transformer spade type bushing terminal.

F. Perform meggar tests on all feeders and motor branch circuit conductors prior to energization of circuits. Provide documentation in standard NETA format to the Engineer for review. Do not meggar check solid-state equipment.

G. Provide non-destructive infrared testing and inspection of all aluminum terminations upon energization and again 60 days after startup under normal load. This is to determine if any early problems develop under full load. Provide NETA format documentation.

END OF SECTION

26 05 20 LOW-VOLTAGE ELECTRICAL POWER CABLES METAL CLAD "MC" CABLE

PART 1 - GENERAL

1.1 This section covers copper multi-conductor metal clad cable, Type MC. Metal clad cable constructions shall conform to UL #1569, UL 83 and N.E.C. Article 330.

PART 2 - PRODUCTS

2.1 Multi-Conductor Metal Clad Cable, Type MC, with copper conductors in sizes #12 thru #6 for continuous operation at a maximum conductor temperature of 90 degrees C dry. Cables shall have Underwriters' Laboratories labels for Metal Clad Cable and are suitable for use as branch circuits in both exposed or concealed work in accordance with the applicable sections of the National Electrical Code, Article 330.

2.2 Multi-conductor, Super Neutral, Metal Clad Cable, Type MC, with copper conductors in sizes #12 through #1/O AWG for continuous operation at a maximum conductor temperature of 90 degrees C dry. Super Neutral Cable, Type MC Cables are comprised of four or more conductors with one neutral per phase for three phase, a ground for four-wire power supply systems to receptacle circuits. Cables shall have Underwriters' Laboratories labels for Metal Clad Cable and are suitable for use in both exposed or concealed work or in accordance with the applicable sections of the National Electrical Code, Article 330. Receptacle circuits requiring separate neutrals, the neutrals shall be considered a current carrying conductor and derated per NEC 310.15.

2.3 Multi-Conductor Metal Clad Cable Conductors shall be copper type THHN with a full sized copper ground conductor and mylar assembly tape. MC cable type utilizing an integrated aluminum grounding/bonding conductor system as the equipment grounding conductor is not acceptable.

PART 3 - EXECUTION

3.1 Multi-Conductor Metal Clad Cable shall be supported and installed per NEC. Article 330. Except not permitted to be run exposed in finished spaces and the use of non-metallic ties for support is prohibited.

3.2 Plastic anti-short bushing (red head) shall be inserted into the armor cover at terminations.

3.3 Branch circuits from panelboards shall be run in conduit to a central junction box in spaces or group of spaces containing terminal blocks and ground bar where all incoming conductors and outgoing MC cable conductors are terminated. At these terminal blocks the transition is made to type MC cable with all terminal points identified along with the circuit numbers. The Multi-Conductor Metal Clad Cable runouts continue to lighting fixtures, receptacles, etc.

3.4 Conductors in central junction boxes shall be labeled indicating panel and branch circuit, refer to Electrical Identification; Section 26 05 53.

END OF SECTION

26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Work includes grounding and bonding of system neutral, equipment and conduit systems to conform to requirements of NEC and as detailed on the plans and in the specifications.

PART 2 - PRODUCTS

2.1 Grounding rods shall be copper clad, molten-welded copper to steel; unless otherwise designated, 0.625 inch diameter x 10 ft. long.

2.2 Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be "Thermoweld" or "Cadweld".

2.3 Ground conductors shall be insulated, identified by green insulation or by painting or taping green at all accessible locations and shall be connected with approved connectors and terminators to boxes, devices, equipment, etc. and to ground bars in panels.

PART 3 - EXECUTION

3.1 Provide a listed intersystem bonding termination system with capacity for a minimum of 5 - #4 - 4awg and 1 - #6 – 2 awg bonding conductor terminations. Locate external to the service entrance equipment and connect to the grounding electrode system.

3.2 Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw in the outlet box. Branch circuit to be connected to grounding screw in the outlet box.

3.3 Extend a minimum #4/0 copper ground cable from the ground bus in the primary service entrance equipment to the street side of the main water meter and to building steel, foundation footing steel (minimum 20 ft. length .50 inch or provide 20 foot #2 AWG, bare copper), driven ground rods outside or buried electrodes; increase ground conductor sizes where required.

3.4 Pad-Mount Transformer Grounding: Bond the high voltage neutral, pothead cases, cable shields, instrument transformer neutrals, low voltage system neutral, all conduits, frame of the transformer, and driven ground rods with copper connections.

3.5 Main service neutral shall be grounded to the street side of the building water service. A bonding jumper shall be installed around the water meter. In addition to using the water service as a grounding electrode, effectively grounded building steel, foundation footing steel (minimum 20 ft. length ½ in. or provide 20 ft. #2 AWG. bare copper) and driven ground rods outside or buried electrode shall be provided and connected. Bond to interior metallic water, gas and all other metallic lines. Conductors minimum size shall be sized per NEC Tables 250.66 and 250.102

3.6 Grounding Bus: Install in electrical service equipment space, telephone equipment rooms, generator room, battery rooms, below raised floors, and elsewhere as indicated.

A. Bus shall be minimum 3/8 inch x 2 inches x 12 inches L. solid copper.

B. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

C. The grounding bars shall be bonded to the building grounding electrode system and the building ground ring.

3.7 The complete metal conduit system shall be used for the equipment grounding system. Conduit systems and associated fittings and terminations shall be made mechanically tight to provide a

continuous electrical path to ground and shall be safely grounded at all equipment by bonding all metallic conduit to the equipment enclosures with locknuts cutting thru paint or enclosures. Bond all conduits entering main breaker panel, and secondary service entrance panelboard with a ground wire connecting the grounding type bushings to the equipment ground bar. Conductors shall be sized per NEC Tables 250.66, 250.102 and 250.122. Bond all communications conduit systems to ground.

3.8 In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, thru distribution and branch circuit panelboards and paralleling all feeders and branch circuit wiring. Grounding conductor sizes shall comply with NEC Table 250.122, minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

A. Connect ground terminal on wiring devices to auxiliary green wire equipment grounding system.

3.9 Ground neutral of all transformers for separately derived systems. Grounding electrode conductor shall be to the street side of the main water service plus a bond ground ran to nearest structural steel in area or to other NEC approved electrodes. A common grounding electrode size #3/0 may be used for multiple separately derived systems. Conductors shall be sized per NEC Table 250.66.

3.10 Motor frames shall be bonded to the equipment grounding system by an independent green insulated copper wire, sized to match equipment grounding conductor. Motors with VFD shall be bonded with flat braided tinned copper straps in lieu of wire.

3.11 Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.

3.12 Equipment mounted on vibration isolation hanger and supports shall be bonded so bond does not transmit vibration. Size bond to match equipment ground conductor.

3.13 A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.

3.14 System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main panelboard enclosure shall be by means of bonding jumpers.

3.15 The building neutral shall be identified throughout with white conductors. Where there are neutral conductors from a separately derived system (such as 120/208 volt, 3 phase, 4 wire where the main building service is 277/480 volt, 3 phase, 4 wire) the neutrals of the two systems shall be separately identifiable per NEC Article 200.

3.16 A minimum #6 ground wire shall be run from each telephone backboard back to the main building ground.

3.17 Steel frame buildings and metal exterior coverings on buildings that are not effectively grounded (i.e., all metal connections bolted w/o insulating washers) shall be grounded thru a low resistance grounding system whether or not a lightning protection system is required. Ground metal exterior coverings and metal roofs with minimum #4 copper conductor at a minimum of two points, intervals not exceeding 100 feet. Ground steel frame buildings at each corner with maximum of every 60 ft. around the outside perimeter by cadwelding #2/0 (#4/0 for buildings over 75 ft. tall) copper conductor to steel columns and extending below ground to driven ground rods; top of 0.625 inch x 10 ft. ground rod shall be minimum of 12 inches below finished grade and 3 ft. out from building foundation. Bond the water service, street side of water meter, to the adjacent perimeter steel column with #4/0 insulated copper conductor. Sleeve all concrete foundations and masonry walls with PVC sleeve.

3.18 Where a 277/480 volt emergency generator is provided on a system having ground fault protection on the normal service and the generator is located in the vicinity of the main electric service equipment, isolate the generator neutral from the generator frame. The generator neutral will be grounded through the main electric service grounding electrode. Bond the generator frame to the equipment grounding conductor. Provide signs at the grounding locations per NEC 700.7 and 701.7.

3.19 To supplement driven ground rods, provide a system of caisson grounds where identified on the drawings. Drop a #4/0 bare copper conductor to the bottom of the drilled caisson and bond to rebar steel before concrete is poured. Extend the unspliced #4/0 bare copper to the building ground bar.

3.20 Connections to driven ground rods or other such electrodes shall be a minimum of three feet from the foundation wall or beyond the roof drip line, whichever is greater.

3.21 The electrodes (driven ground rods) of the electrical grounding system shall not be used for the electrodes for the lightning protection system, and vice versa. However, these two systems shall be bonded together at one point per NEC.

3.22 Provide sign at normal service “WARNING – SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCES(S) IS ENERGIZED”.

END OF SECTION

26 05 28 COMMUNICATIONS SYSTEMS PATHWAYS AND SUPPORT EQUIPMENT

PART 1 - GENERAL

1.1 Scope of Work

A. Work consists of pathways to carry communication wiring of all descriptions, including empty conduits, conduit sleeves, cable tray, ladder rack, basket tray, cable management systems, etc.

B. Work includes support equipment for telecommunications cabling including backboards, rough-in boxes and cabinets.

1.2 Quality Assurance

A. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.3 Shop Drawings – Submit shop drawings including product data sheets and diagrams per requirements including the following:

A. A complete list of materials with model and part numbers and reference to the specification paragraph number.

B. A complete set of detailed manufacturers specifications describing and illustrating all standard and special components and materials.

C. A complete set of drawings of special items. Submit drawings of cable tray and accessories including clamps, brackets, hangar rods, splice plate connectors, expansion joint assemblies, and fittings, showing accurately scaled components. Submit manufacturers data including, but not limited to, types, materials, finishes, width, rung spacings, inside depths and radii. For side rails and rungs, submit cross sectional properties including Section Modulus (Sx) and Moment of Inertia (Ix).

D. Submittals that do not contain all this required information WILL BE REJECTED.

1.4 Drawings

A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of their work prior to submitting system layout drawings.

1.5 Related Work by Others

A. Communications cabling shall be included as stated in the specification section for each individual system.

PART 2 - PRODUCTS

2.1 Conduit Systems

A. Refer to specification section 26 05 33 Raceway and Boxes for Electrical Systems.

2.2 Wireways shall be metal trough with a removable hinged cover and generous knockout arrangement. Provide necessary ells, tees and fittings for a complete installation. All components shall be hot dip galvanized after fabrication or provided with a rust inhibiting phosphatizing coating and finished in baked enamel. All hardware shall be plated to prevent corrosion. Wireways shall be manufactured by Square D, Weigman, Hoffman, Austin or Milbank.

2.3 Cable Management System

A. Provide pre-manufactured cable supports as manufactured by Panduit, Caddy, Eaton B-Line, Mineralac, Mono-Systems or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

2.4 Rated Wall through Penetration

A. Fire-rated pathway shall contain built-in fire sealing system for installation in fire rated wall. The system shall automatically adjust to installed cable loading and shall permit cables to be installed, removed or retrofitted without the need to adjust, remove or reinstall firestop materials. The pathway shall be UL classified and tested to ASTM E81H (UL1479) requirements. Ez-Path Series 44 or equal.

2.5 Cabinets

A. Telephone, communication and data systems cabinets shall be provided by the same manufacturer as panelboards with matching trim, hinges, latches, locks, finish and color unless included as part of another communication system specification. Refer to Section 26 24 16 "Panelboards" and Section 26 27 16 "Electrical Cabinets and Enclosures".

2.6 Backboards

A. Refer to Section 26 05 04 – Basic Electrical Materials and Methods.

2.7 Rough-In Boxes

A. Refer to Section 26 05 33 – Raceway and Boxes for Electrical Systems.

B. Refer to drawings for types, quantities and configurations of outlet boxes used to serve communications cabling.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 ft.
2. Conduit and cable used for electrical power distribution – 1 ft.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 5 kV – 5 inches.
5. Power lines over 5 kV. – 24 inches.

C. Backboards and cabinets shall be installed in telecommunications rooms/spaces to support telecommunications equipment and wiring. Coordinate locations of backboards and cabinets with Architect prior to installation.

D. Provide necessary pathways in areas that have exposed structure or plastered ceilings to provide a wiring path for cables from area above suspended ceilings to respective backboards.

E. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

3.2 Conduit Systems

A. No section of conduit shall be longer than 100 feet between pulling points.

B. No more than two 90 deg. bends in a section of conduit between pulling points.

C. Each section of conduit shall be labeled for length, destination closet and origination closet.

D. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

E. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.

F. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.3 Wireways

A. Wireways shall be supported with factory made hangers designed expressly for this purpose and 0.375 inches diameter solid hanger rods approximately 5 ft. on center or approved strap hangers for surface mounting.

3.4 Ladder Rack

A. All fittings, supports, splices, etc. for the raceway system shall be installed to provide a complete assembly – including fasteners, hardware and other items required to complete the installation as indicated on the drawings.

B. Cable raceway shall be capable of carrying a uniformly distributed load of 95 lbs./ft. on a 5 foot support span with a safety factory of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capacities.

C. “Ladder Type” cable trays shall be supported from continuous wall inserts and shelf brackets in a manner to permit laying cables in the trays without interference of a supporting rod on one side. All inserts, supports and necessary wall modifications and bracing shall be furnished by this Contractor.

3.5 Cable Management System

A. The drawings do not indicate specific routes for telecommunications cables. The Division 27 Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Division 27 Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contractor shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 foot.
2. Conduit and cable use for electrical power distribution – 1 foot.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 2kVA – 5 inches.
5. Power lines over 5kVA – 24 inches cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.6 Rated Wall through Penetration

A. Where cable path is to penetrate fire rated walls a fire sealing system is to be installed. Provide multiple units equal to width of cable tray using a multi-gang kit.

3.7 Grounding

A. The main telecommunications wiring closet (TC-01) shall be provided with the Main Telecommunications Ground Bar (MTGB). The MTGB shall be bonded to the building main electrical system ground at one point and shall be bonded to one additional building electrical system ground (such as building steel).

B. Each Telecommunications Closet (TC) shall be provided with a Telecommunications Ground Bar (TGB).

C. Provide a Telecommunications Bonding Backbone (TBB) consisting of a #6 AWG conductor (unless otherwise indicated on drawings) in 0.75 inches schedule 40 PVC conduit from the MTGB to each TGB.

D. All grounding and bonding shall be in conformance with the National Electric Code and as recommended by EIA/TIA-607.

E. Bond all communications conduits, wireways, cable tray, conduit stubs and sleeves, etc. to the electrical / building grounding system. Ground cable tray to the ground bus and bond each joint with bonding jumpers for an absolute ground. All metallic conduit stubs to the cable tray for telephone, data, power or even empty conduits for future use shall be bonded to the cable tray to ensure ground continuity between the different raceway systems.

F. Provide means of bonding each joint for absolute grounding of the cable tray and ladder rack.

3.8 Cabinets

A. Mount top of wall mounted cabinets 6 ft.-0 inches above floor. Coordinate location of recessed cabinets to be accessible and to avoid interference with other equipment and trades.

B. Each cabinet shall be fitted with a full size 0.75 inches thick backboard for mounting terminal strips, equipment, etc.

3.9 Identification / Labeling

A. All continuous communications pathways such as conduit, cable tray, etc. shall be labeled to indicate origination and destination. Label shall be applied every 50 ft. wherever accessible or subject to administration. Coordinate label information with Owner.

B. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned / prepped area of raceway.

3.10 As-Built Documentation

A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate “as-built” locations to show the actual route for the communications systems pathways.

B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.

C. Component Service Manuals: Include information for testing, repair, troubleshooting, assembly, disassembly, and required / recommended maintenance intervals for all types of pathways.

3.11 Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means; refer to Raceway and Boxes for Electrical Systems Section 26 05 33 and Firestopping 26 05 05.

END OF SECTION

26 05 33 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 This specification section covers common conduit systems, boxes, firestopping and sleeves. Where other methods are specified under separate sections for specific applications, the specific application requirements shall govern.

1.2 Refer to Section 26 05 05 Firestopping and Division 07 for firestopping requirements.

1.3 Refer to Section “Communication System Pathways and Support Equipment” for future communication system.

PART 2 - PRODUCTS

2.1 Conduit Type - Application (Use only conduit types listed)

A. Conduit - Rigid or Intermediate Grade Galvanized Threaded.
Application - restrictions - (Not to be used in):

1. Direct buried in corrosive soils.
2. Corrosive atmospheres.

B. Conduit - Rigid Aluminum threaded.
Application - restrictions - (Not to be used in):

1. Underground.
2. Corrosive atmospheres.
3. In concrete.

C. Conduit - Thinwall EMT.
Application - restrictions - (Not to be used in):

1. Poured concrete.
2. Exposed to weather.
3. Underground.
4. Exposed in mechanical equipment or other equipment/process rooms below 48 inches.
5. Hazardous or corrosive atmospheres.
6. Not to be used for medium voltage (2001 volts or higher) cable.
7. Not to be used in utility tunnels.

D. Conduit - PVC Type 40 (Schedule 40) rigid, conforming to ANSI, NEMA specifications and each length UL labeled.
Application - use limited to:

1. In or under concrete slabs on grade where permitted by electric legend on the drawings.
2. Exterior use when encased in 3 inch concrete.
3. Direct buried, underground when indicated on drawings.

E. Conduit - PVC, NEMA Type TC 6, rigid, conforming to ANSI, NEMA specifications and each length UL labeled.
Application - use limited to:

1. Exterior use when encased in 3 inch concrete, for duct bank use only.

F. Conduit - Flexible Metal (Greenfield type), galvanized steel or aluminum.
Application - use limited to:

1. Connection to lighting fixtures; not over 6 ft. in length. Note: Metal-Clad Cable: Type MC may be used for fixture whips only; must contain green insulated ground conductor, be limited to 6 ft. in length and must use UL approved connectors.
2. Narrow movable partitions where other raceways are not practicable, when approved by the Architect or Engineer.
3. Connections to transformers, dynamic equipment and for motors only when in air streams or plenums.
4. In existing walls for remodel projects, vertical drops to outlets and switches; no more than 3 ft. out the top of the wall.

G. Conduit - Liquidtight Flexible Metal.
Application - use and limitations:

1. Connections to all motors, except in air stream or plenum.
2. Connections to controls on dynamic equipment, transformers, etc., outdoors and indoors in wet locations.
3. Use not permitted underground or where subject to physical damage.

H. Plastic jacketed rigid steel conduit shall be ETL performance verified. Application – use in corrosive atmospheres including swimming pool areas, pool equipment rooms, chlorine storage areas, etc. and other areas as noted on the drawings.

I. Conduit Reinforced Thermosetting Resin RTRC shall meet UL 1684 for extinguishing flame and shall not contain any compounds that release halogens.
Application use limited to:

1. In or under concrete slabs on grade where permitted by electric legend on drawings.
2. Exterior uses when encased in 3” concrete.
3. Direct buried, underground when indicated on drawings.
4. Exposed corrosive atmospheres including pool equipment rooms, chlorine storage areas, etc. and other areas as noted on drawings.
5. Where subject to physical damage shall be identified for use i.e., types RTRC-X W.

2.2 Conduit sizes

A. Conduit sizes shall be code minimum, except where conduit sizes shown on the drawings exceed code minimum, the size shown on the drawings shall prevail.

2.3 Conduit Fittings

A. Fittings and workmanship shall ensure electrical continuity. All conduit systems in poured concrete shall be concrete tight.

B. Application of bushings, locknuts and insulated fittings shall comply with NEC requirements.

C. Use conduit fittings as manufactured by Efcor, Steel City, Raco, Midwest, Appleton, ETP / O-Z / Gedney, American Fitting Corporation or T&B, equal to the following catalog numbers:

1. Rigid and intermediate conduit
   - all fittings, couplings and connectors shall be threaded type.
   - grounding bushings, malleable iron; insulated; Steel City BG-801; Midwest Series GLL.
2. EMT
   - fittings shall be all steel, set screw or compression type, concrete tight.
   - set-screw type couplings; Midwest Series 460; Steel City TK 121; Appleton TW 50S.
   - compression type couplings; Midwest series 660S; Steel City TK111; Appleton TWC50CS.

- set-screw type connectors; Midwest Series 450; Steel City TC 121; Appleton TWC 50S.
- compression type connectors; Midwest Series 650; Steel City TC111; Appleton TW50CS.

3. Flexible metal conduit
   - malleable iron, "squeeze" type, non-insulated; Midwest series 1708; Steel City XC 901; Appleton 7481V. (For lighting fixture whips only - all steel or die cast screw in connector; Midwest 771; Steel City XC 241; Appleton SGC 50DC).
4. Liquid tight conduit
   - steel or malleable iron; Midwest Series LT; Steel City LT 100; Appleton ST.
5. PVC Type 40 and Type TC-6
   - couplings and fittings socket type solvent weld, coupling and solvent by same manufacturer as conduit.
6. RTRC
   - Coupling and fittings socket type adhesive jointing. Coupling and adhesive by same manufacturer as conduit. Gasketed jointing system may be used underground where encased in conduit.

2.4 Boxes

A. Junction boxes and pull boxes shall be code gauge galvanized steel with multiple screw fasteners and galvanized steel covers.

B. Outlet boxes all steel construction with galvanized or plated finish or otherwise all metal, by Steel City, Appleton, Crouse Hinds, R&S or Raco.
   1. Lighting fixture outlet boxes 4 inches square or octagonal, 2.125 inches deep, with 0.375 inch fixture studs. Equal to Steel City Series 54171; Series 52171 with FE 421 stud. Fixtures weighing more than 50 lbs. shall be supported independently of the outlet box.
   2. Flush mounted device outlet boxes shall be minimum 4 inches square. Provide extension rings as required. Use Erico Caddy No. H2-3 mounting support plate where metal studs are used.
   3. Device rings in finished masonry or tile walls shall be square corner masonry type with no extended ears, to allow flush mounting of plates.
   4. Surface mounted device boxes shall be cast "FS" type or special surface mounted boxes for use with surface raceway systems.

C. Floor boxes shall be UL listed for its application as manufactured by Hubbell, Steel City, Walker, Raco or Wiremold. Drawings identify material type.

D. Provide water tight boxes, slip expansions and bonding jumpers where dictated by construction conditions.

E. Terminations at boxes shall be secured by locknuts or approved bushings.

F. All electrical penetrations through the exterior wall of the bus garage and bus wash shall use a flashing panel box manufactured by Quickflash.

2.5 Surface Metal Raceways

A. Snap on cover types by Mono-Systems, Panduit or Wiremold / Walkermold with prime gray finish (enamel finish coat to match room finishes in remodel areas). Application - permitted only when specifically shown on the drawings.

   1. Fittings, boxes and extension rings: Furnish manufacturer’s standard accessories; match finish of raceway.

2.6 Sleeves and Openings

A. Sleeves and formed openings shall be placed in walls, partitions, floor slabs and poured concrete roof decks for the passage of conduit, cable, wireway, cable tray and bus duct. Sleeves and formed openings are not required:

1. In floor slabs on grade.
2. Where conduit is installed before the wall, partition or slab is constructed.
3. Openings are cut for conduit passage and patched with equal or comparable material to close the space around the conduit.
4. In stud and gypsum board or plaster walls and partitions which are not fire rated.
5. For conduit passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions. Sleeves are required however, for which expansion, contraction and other movement can be expected.
6. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.
7. In large floor openings for multiple pipe and duct risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after conduits are set.
8. Sleeves for passage of conduit and cables shall be schedule 40 black steel pipe or galvanized rigid conduit. Rectangular sleeves for cables, wireway, cable tray and bus duct shall be 18 gauge galvanized steel in poured concrete floors, walls and roof decks; 26 gauge galvanized sheet steel in other than poured concrete.
9. Sleeves shall be sized to afford 0.25 inch to 0.75 inch clearance space.

2.7 In areas having special membrane waterproofing in or on the floor slab, a Josam 26420, or equal approved by the Architect, riser sleeve with clamping ring and auxiliary conduit sleeve extending 4 inches above finished floor or 8 inches above finished roof shall be used. Waterproofing membrane for roof and floor construction shall be secured by the clamping ring. These are to be used in areas having special membrane water-proofing in or on the floor slab and at roof decks.

2.8 Multiple conduits extending through the roof may be fitted with a manufactured pipe curb weatherproofing assembly equal to Pate # pca, lpca and mpca as an alternative to that specified in paragraph 2.7 above.

2.9 Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where conduits penetrate walls, floors, ceilings or overhead structure.

2.10 Anchors and Fasteners

A. Anchors and fasteners shall be of a type designed and intended for use in the base material to which the material support is to be attached and shall be capable of supporting the intended load and withstanding any associated stresses and vibrations.

B. In general, screws shall be used in wood, masonry anchors on concrete or brick, toggle bolts in hollow walls, and machine screws, bolts or welded studs on steel.

C. Nails shall not be used except for temporary support or for light loads in wood frame construction.

D. In outdoor locations or other corrosive atmospheres, the anchors and fasteners shall be non-corrosive or have suitable corrosion resisting coatings.

PART 3 - EXECUTION

3.1 Conduit shall be run concealed in all finished areas of new construction and elsewhere unless specifically indicated or upon specific permission by the Architect. All conduit shall parallel building lines.

3.2 Conduit shall be run overhead and shall not be run in or below concrete slabs unless specifically indicated on the drawings and in the legend on the drawings.

3.3 Where feeders are permitted to be run below floor slab on grade, they shall be installed in non-metallic conduit encased in 3 inch concrete using galvanized rigid steel or RTRC (equal to Champion Fiberglass) elbows with all necessary fittings and couplers. (NOTE: Where not required to be run overhead, branch circuits may be installed in 1 inch or smaller Schedule 40 PVC conduit below the vapor barrier, shall have a minimum of 6-inch fill over the conduit below the vapor barrier without concrete encasing the PVC. This PVC conduit shall not stub up more than 18 inches above the finished floor and shall be concealed in walls).

3.4 All conduits installed below concrete slab on grade shall have a minimum of 6-inches fill over the conduits in order to prevent accidental damage to conduits should the floor be saw-cut in the future.

3.5 Conduits shall not be installed above the vapor barrier in concrete floors poured on grade.

3.6 Conduit crossing building expansion joints shall have expansion provisions with grounding continuity; use special expansion fittings or other NEC approved method. Refer to the Architectural and Structural floor plans and details for locations of expansion joints.

3.7 Do not install wall-mounted boxes back-to-back in opposite sides of wall; in stud walls, boxes shall be on opposite side of studs. In acoustic rated and fire rated walls boxes shall be separated a minimum of 24 inches.

3.8 Boxes not otherwise accessible in ceilings and walls shall be made accessible by installation of hinged door access panels. Refer to Section 26 05 04 - Basic Electrical Materials and Methods.

3.9 Use cast floor boxes for installation in slab on grade; formed steel boxes are acceptable for other installations.

3.10 Work shall be so planned as to:

A. Minimize the number of offsets and junction boxes. For feeder conduits, use all long radius conduit bends or accessibly located large junction boxes with screw covers.

B. Generally run conduit and conductors as high as practicable against underside of floor slab in concrete construction or immediately below the top chord of bar joist construction unless otherwise shown. This high level zone shall be used for running electrical raceways. Running conduits promiscuously at various levels and directions will not be acceptable. Runs at bottom chord level or ceiling grid level will not be acceptable.

C. Where spray on fireproofing is used, coordinate with the General Contractor about installing supports, panel feeders and larger conduits before fireproofing is applied. Branch circuit conduits and smaller size conduits may be run as high as possible on stud walls that go all the way up to the structure; this will minimize damage to spray on fireproofing. Patch and repair damaged spray on fireproofing caused by electrical installation; conduits shall not be fully covered with fireproofing.

D. Coordinate activity in advance to avoid interference with other trades.

E. Provide access to all junction and pull boxes.

F. Maintain 6 inches from conduit to paralleled hot water piping and 4 inches from cross piping and 12 inches from generator exhaust piping.

3.11 Secure feeder conduit to basic structural elements with galvanized strap hangers and clamps; use of trapeze type hangers is encouraged for multiple conduits where space will permit. Galvanized metal clamps and screws may be used for attaching and supporting branch circuit conduit. Non-metallic fasteners shall not be used except plastic inserts may be used in concrete for small conduits. Vertical conduits shall be supported at each floor by clamps.

3.12 Surface mounted horizontal and vertical conduit supports on walls up to a height of 7 feet-0 inches above the floor shall be one or two hole sheet metal pipe straps. Pinch type hangers similar to Minerallac type may only be used at heights greater than 8 feet-0 inches. The use of pinch type hangers similar to Minerallac type are expressly prohibited on ductwork, air handling units and other mechanical equipment below 8 feet-0 inches.

3.13 During construction temporarily cap open ends of conduit. Caution trades to take special care of runs in concrete slabs during pouring.

3.14 Empty conduit installed for communications use or for future systems shall have an insulated pull wire or heavy nylon cord inserted for use in pulling wires.

3.15 Pull mandrel or large swab thru conduit to ensure freedom from debris before pulling wires. Use pulling lubricants sparingly.

3.16 Sleeves for passage of conduit, cables, wireway, cable tray and bus duct shall be placed in the initial stages of construction before concrete, masonry and other general construction activity. Means shall be taken to ensure that the sleeve will not move during or after construction. Beams, columns and other structural members shall not be sleeved except upon approval of the Architect.

3.17 Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1 inch above finished floor. Refer to the following paragraph for qualifications and exceptions relating to firestopping.

3.18 Refer to 26 05 05 Firestopping. Sleeves which are a part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.

3.19 Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the conduit, cable, cable tray, bus duct and raceway shall be closed with caulking to retard the passage of smoke.

3.20 Where permitted by OBC Section 712 Penetrations, metallic conduits requiring no pipe sleeves in passing thru concrete floors or concrete or masonry walls and partitions, the annular space shall be closed full depth of the penetration with materials and methods compatible with the floor, wall or partition material (concrete, grout or mortar).

3.21 Conduits, wire and cables entering from outside the building shall be sealed water and moisture tight. Seal between conduit and sleeves, conduits and core drilled holes and around conductors inside conduits. Provide cast iron pipe or schedule 40 galvanized steel conduit sleeves in exterior walls below grade, with intermediate wall stop and anchor collar set in place before concrete pouring. Sleeve shall be a part of the sealing assembly. When the wall opening is core drilled the wall sleeve may be omitted. A mechanically compressed rubber sealing assembly equal to Thunderline Corp. "Link-Seal" shall be placed in the annular space between conduit and sleeve or core drilling.

3.22 Conduits extending through the roof shall be made watertight by means compatible with the roofing system and as directed by the Roofing Contractor (the company who presently holds the warranty on the roof) and approved by the Architect.

3.23 Conduit, wire and cable, where exposed to different temperatures, shall have raceway or sleeve filled with approved material to prevent circulation of warm air to cold.

3.24 Power actuated fasteners of any type are prohibited in occupied buildings. This includes anchors which are driven into place by any device which produces an impact force by use of a powder charge, compressed air, gas or any other propellant.

3.25 Provide four (4) 1 inch diameter spare conduits for each flush mounted branch circuit panelboard; extend from top of panelboard to above an accessible ceiling for future use.

3.26 All conduit terminations to be equipped with locknuts and bushings. Conduits 1-1/2 inches and larger shall have insulating bushings, grounding lug and shall have locknuts inside and outside the enclosure.

3.27 Outlet Box Installation

A. Set box square and true with finished building surfaces and trim.

B. Secure boxes firmly to building structure.

C. Verify location of outlets and switches in finished rooms with Architectural Drawings of interior details and finish. In centering outlets and locating boxes, allow for overhead pipes, ducts and mechanical equipment, variations in fireproofing and plastering, window and like, and correct any inaccuracy from failure to do so without expense to the Owner.

D. Maintain symmetry of all outlets as closely as possible contained within Architectural Elevation. For example, the Contractor shall center light fixture over doorway or receptacle in section of masonry wall, if shown in that approximate position. If receptacle is shown in same location as counter or bench, determine countertop height and set receptacle to clear top and trim of counter and render outlet easily accessible.

E. In the event of conflict between locations of electrical outlets as shown on the Electrical Drawings and on the Architectural Drawings, outlets shall be installed in accordance with the latter.

F. Locate light switches on latch side of door and verify door hinge location in field prior to switch outlet installation.

G. The Owner reserves the right to relocate any device as much as 10 feet-0 inches (measured horizontally) from its indicated location at no additional cost, provided the contractor is notified prior to roughing that device in.

3.28 Contractor shall record carefully on a set of "as built" prints the exact location of all feeder conduits.

3.29 Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only - ground conductors are not counted when determining maximum fill for this purpose.

END OF SECTION

26 05 43 MANHOLES, PULLBOXES, HANDHOLES, UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEM

PART 1 - GENERAL

1.1 Work includes manholes, pullboxes, handholes and underground duct banks complete as shown, including excavation, backfill and accessories.

PART 2 - PRODUCTS

2.1 Manholes

A. Manholes shall be constructed of reinforced concrete either 3500 lb. test poured in place or precast type, complete with cover, accessories and accommodations for duct banks as shown. Construction shall be for heavy-duty traffic service to meet Ohio Department of Transportation Specifications H 20.

B. Precast manholes including moving and setting installation requirement shall be submitted for approval.

C. Refer to the drawings for number and sizes of manholes required.

D. Furnish ground rod for each manhole and bond all exposed metal parts, including the ring for the manhole cover, to rod with minimum #8 copper conductor.

E. Cables thru manholes shall follow the walls and be supported with insulators. Diagonal or straight thru cable runs are not acceptable.

F. The use of precast concrete manholes is encouraged. Acceptable manufacturers: Oldcastle Infrastructure, Mack Industries, Norwalk Concrete Industries , E.G. Babbert or approved equal.

G. Cover shall have bolt down provisions and have "ELECTRIC" or "TELEPHONE" cast in top. Covers weighing less than 100 pounds shall have bolted fastening provided.

H. Provide pulling rings on each side of manhole.

I. Cable Racks

1. Hot dipped galvanized, heavy-duty rack consisting of heavy gauge sheet steel piece anchored to wall with four (4) insulation support arms. Insulators to the white glazed saddle type. Support arms shall be 18 inches long.
2. Provide sufficient cable supports on walls for feeding being installed under this contract, plug additional supports on other walls for future use.
3. Manufacturers: Rack Hubbell #DU13B7, Supports-Hubbell #DU353 and Insulators – Hubbell #DE3U1 or approved equal

2.2 Pullboxes

A. Pullboxes shall be constructed of reinforced concrete either 3500 lb. test poured in place or precast type, complete with cover, accessories and accommodations for duct banks as shown. Construction shall be for heavy-duty traffic service to meet Ohio Department of Transportation Specifications H 20.

B. Precast pullboxes including moving and setting installation requirement shall be submitted for approval.

C. Refer to the drawings for number and sizes of pullboxes required.

D. Furnish ground rod for each pullbox and bond all exposed metal parts, including the ring for the manhole cover, to rod with minimum #8 copper conductor.

E. The use of precast concrete manholes is encouraged. Acceptable manufacturers: Oldcastle Infrastructure, Mack Industries, Norwalk Concrete Industries, E. G. Babbert or approved equal.

F. Cover shall have bolt down provisions and have "ELECTRIC" or "TELEPHONE" cast in top. Covers weighing less than 100 pounds shall have bolted fastening provided.

G. Provide pulling rings on each side of pullbox.

2.3 Handholes

A. Constructed of polymer concrete reinforced with fiberglass. Cover to be bolted with stainless steel pentahead bolts. Manufactured by Quazite, Oldcastle, or MacLean Highline.

B. Enclosures, boxes and cover are required to conform to all test provisions of ANSI/SCTE 77 “Specifications For Underground Enclosure Integrity” for Tier 15 (unless marked otherwise on drawing) applications. When multiple Tiers are specified the boxes must physically accommodate and structurally support compatible covers while possessing the highest Tier rating. In no assembly can the cover design load exceed the design load of the box.

C. All components in an assembly (box and cover) are manufactured using matched surface tooling. All covers are required to have a minimum coefficient of friction of 0.05 in accordance with ASTM C1028 and the corresponding Tier level embossed on the top surface.

D. Independent third party verification or test reports stamped by a registered Professional Engineer certifying that all test provisions of this specification have been met are required with each submittal.

2.4 Duct Banks

A. Duct material, where concrete encased, shall be concrete encasement type PVC with 3 inches envelope of 3,000 psi concrete. Fittings shall be fully compatible for the duct material, assembled with recommended sealants to form a watertight joint. All bends shall be long sweep type; use proper adapters between PVC duct and galvanized rigid steel.

B. Ducts shall be carefully placed, aligned and tied to avoid disruption during pouring using plastic spacers.

C. Duct runs shall pitch slightly toward manholes to provide drainage; pitch away from building entrance.

D. Pull a mandrel or swab through each completed duct run; leave a No. 10 THW copper or equivalent, pull wire in all unused duct runs: plug ends of all unused duct runs.

E. Use rigid galvanized steel conduit at all bends and within five (5) ft. of the building wall.

F. Provide taper end bells at all pull in points.

G. Mark the top of all underground duct runs with one of the following methods:

1. Concentrated red dye or powder on top.

2. 6 inches wide yellow plastic tape, with black letters; place approximately 18 inches above on the centerline of the duct bank.

EXECUTION

3.1 Installation

A. Refer to Section 26 05 09 for excavation and backfill.

B. Manholes, pullboxes, handholes and ducts shall be placed only on firm soil, carefully graded. Tamped sand or gravel shall be used to compensate for over excavation.

C. Use saw cuts where existing paving, walks or curbs are cut. Replace all surfaces to near original condition as practicable.

D. Coordinate duct bank, pullbox, handhole and manhole locations with underground utilities and piping.

E. Duct runs shall be covered only after inspection and approval by the Engineer or the Architect.

F. Where concrete encased ductbanks meet building walls and manhole walls, drill and set a minimum of four size 6 reinforcing bars into manhole wall and builder walls and extend bars parallel to conduits 5 feet beyond the area excavated for manhole. Also provide size 3 cross-ties (top and bottom) 12 inches on center. Where ductbank crosses road also place rebars to extend under roadbed and 5 feet beyond.

G. Handhole installation over excavate hole by 6” to 8”, provide minimum 6” bedding of compacted crushed stone with 6” to 12” extension beyond sides of box. Fill and compact with crushed stone around sides of box. Top of box shall be flush with finish grade.

3.2 Grounding Underground Distribution System Components

A. Grounding handholes, pullboxes and manholes: Install a driven ground rod through floor, close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before structure is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into handhole through a waterproof sleeve in handhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Grounding Connections to Handhole, Pullbox and Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

END OF SECTION

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Equipment Identification

A. Identify all the following items with laminated plates:

1. Unit substations, medium voltage and secondary distribution switchgear, and switchboards, including all subassembly switches.
2. Every motor, lighting and equipment controller and disconnect switch.
3. Panelboards.
4. Motor control centers and motor controller panelboards and individual motor starters within panelboards.
5. Transformers.
6. Automatic transfer switches.

B. Nameplate on motor controllers, disconnect switches, automatic transfer switches, switchgear, switchboards, panelboards and transformers shall indicate source, voltage, disconnect location, and load served.

C. Equipment on the emergency systems shall be identified with nameplates having a red background. Outlets on the emergency systems shall be identified red. This shall be accomplished by using red devices or by providing a coverplate with "EMERGENCY" engraved on the face; fill engraving with red paint or equal.

D. Branch circuit panelboards:

1. Identify panel designation on directory card within the panel.
2. Fill out branch circuit directory indicating circuit number and area served, rooms, group of rooms, lighting, convenience outlets, motors, etc. Card index shall be neatly typed. Provide electronic file for card using Excel.
3. Update or replace branch circuit directory in existing panelboards in areas of alteration.
4. Branch circuit phase conductor color format shall be permanently identified inside each panelboard.

E. Conduit and junction boxes:

1. Color code or label all junction boxes and exposed conduit at 20 ft. intervals. Coding shall be painted or labels of the pre manufactured type permanently mounted with metal or plastic band.
2. Provide a color identification scheme under heavy plastic cover hanging in the electrical rooms; identification shall be:
   a. Emergency - Orange
   b. Normal - Black
   c. Fire Alarm - Red
   d. Nurses Call - Green
   e. Sound - Blue
   f. Telephone - Yellow

F. Wire identification:

1. Identify communications and signaling system wiring and branch circuit wiring by circuit number in panels and motor control center wiring gutters by means of permanent durable wire markers wrapped around or fastened to conductors. This shall be done concurrently with pulling of conductors.

2. Wiring or fiber cabling installed by Contractor for termination by Owner's vendor such as for telephone or data systems shall be identified at both ends utilizing the alpha/numerical identification schedule established by the system vendor.

G. Medium voltage cable identification:

1. Identify each medium voltage cable passing through each electric manhole and pullbox with a stamped brass or stainless steel tag indicating phase and circuit number or load; secure to cable with permanent strap or band.

H. For disconnecting means where power can be backfed (like tie breaker) provide permanent sign at disconnecting means saying: 'DANGER – CONTACTS ON EITHER SIDE OF THIS DEVICE MAY BE ENERGIZED BY BACKFEED.' Also, provide a single-line showing local switching arrangement on permanent sign.

PART 2 - PRODUCTS

2.1 Nameplates

A. Nameplates shall be laminated phenolic with black surface (red surface for emergency) and white core. Use 0.0625 inch thick material for plates up to 2 inches x 4 inches and 0.125 inch thick for larger sizes. The lettering shall be Condensed Gothic with space between the lines equal to the width of the letters. Use 0.25 inch minimum height letters on the small plates increasing the size proportionately to plate size.

B. The lettering on the plate shall indicate the name of equipment, the specific unit number, voltage, phases, which panel, switchboard or motor control center the equipment is served from, and any other reference data pertinent to the operation. Names and numbers shall coincide with those listed on the drawings. Sample: Panel 3A; 277/480 V, 3 phase, 4 wire, served from unit substation USI.

PART 3 - EXECUTION

3.1 Nameplates shall be secured with screws, one on each end.

END OF SECTION

26 05 65 SPECIFIC WIRING APPLICATIONS

PART 1 - GENERAL

1.1 Specific wiring applications are identified. Refer to applicable sections of the specifications.

PART 2 - PRODUCTS

2.1 Materials and equipment shall be as indicated on the drawings and in the specifications.

PART 3 - EXECUTION

3.1 Final connections to fixture pigtails shall be made with approved pressure connectors such as 3M "Scotchlok".

3.2 Miscellaneous Equipment Connections

A. Various items of equipment such as kitchen, laboratory, laundry, etc. will be furnished and set in place by other trades. This equipment, unless otherwise shown on the drawings, will be furnished with necessary electrical outlets, operating and control switches, terminating in an electrical outlet box, or equivalent electrical connector located on the equipment. This Contractor shall furnish power wiring to these various items of equipment and connect them up complete and ready for operation.

B. Where disconnect switches are indicated or where otherwise required, these shall be mounted in an accessible location; but in the case of laboratories, kitchens and finished areas, in an inconspicuous a place as possible. Under counter installation of disconnect switches is preferred to locations above the counter, however, care shall be taken that such switches will be accessible and do not interfere with installation of the equipment.

C. Roughing in drawings for equipment shall be obtained from the Architect as the time approaches when such equipment is required. (Allow a reasonable period from the time of notice to secure this information.)

3.3 Miscellaneous Wiring and Interlocks

A. Various items of work in connection with interlocking motor and starter operations and providing wiring to serve equipment which is furnished by other trades.

B. Interlocks between motor controllers for purposes of accomplishing sequence control or simultaneous operation of motors are all to be included by the Contractor. Requirements for a simple simultaneous motor operation interlock are indicated by a schedule on the drawings. These interlocks consist of auxiliary contacts on the starter of the lead motor wired in, according to standard diagrams of the motor starter manufacturer to energize the holding coil of the starter for the motor. These interlocks shall be thru the "automatic" position only of the starter where HOA switches are supplied. Where interlocks, other than the simple sequence above are required, these shall be as described hereinafter. This Contractor shall inquire of the Engineer during bidding, or at the earliest practical date, regarding any questions which may arise regarding the intention and scope of this work. This Contractor shall furnish extra contacts for their starters where required, in lieu of which they may furnish externally mounted relays to accomplish the specified function.

C. The following is a list of equipment and systems requiring wiring. Note that these are in addition to standard interlocks which are scheduled on the drawings.

1. Refer to the Fire Alarm Specification 28 31 00 for Smoke Damper Operation Requirements.

2. Exterior lighting control shall consist of a combination multiple circuit timer and photoelectric cell system furnished by this Contractor. Controls shall be equal to Tork Time Controls, Inc. Model DZS400BP for 3 circuit (Model DZS400BP for 2 circuit) (Series DG100A timer for one circuit without photocell); Intermatic ET2800 or Sangamo equivalent, and one photoelectric cell, arranged and wired so as to turn on lights automatically during darkness and turn off automatically at a predetermined time. The photocell shall be mounted on the north wall of the building, away from interfering light sources, and wired down to the contactor. Timer shall be mounted in a surface mounted panel with lock. Include a hand off automatic switch to bypass the automatic operation. Control circuit shall operate electrically operated, mechanically held contactor to control lights. Provide auxiliary relay with contactor where required.
3. Remote Lighting Control - Furnish and install a complete system of remote control of lighting panels as shown. Controls to consist of ASCO electrically operated and mechanically held contactors in the lighting panel mains operated from on off manual switches with pilot lights thru three wire circuits to close the panel feeder circuit and light all lamps connected to that panel (provided the branch circuit breakers are "on"). Remote switches with pilot light shall be two gang type as specified under wiring devices. Furnish necessary ASCO remote control relays to work in conjunction with the mechanically held contactors. Pilot light shall light when switch is "on".
4. Motorized Doors - Door controls, including relays, operating switches, limit switches and wiring diagrams, will be furnished by the door equipment supplier. These shall be received by the Contractor and installed complete and ready for use, in accordance with approved wiring diagrams. Where motorized doors are located in fire walls and smoke partitions, provide a signal from the fire alarm system to disable the door controls and allow it to be manually operable while maintaining its latching feature.
5. Conveyors, furnished by equipment suppliers, are equipped with motor starters and limit switches requiring interlock wiring. Perform all necessary wiring in accordance with diagrams furnished by the supplier. Starters and switches will be pre-mounted on the equipment.
6. Vacuum Cleaning System - Furnish a system of switches, pilot indicating lights and wiring to control the vacuum producer from various locations as shown. All equipment and wiring shall be 115 volt.
7. Lawn Sprinklers Control.
8. Well and Pump - Interconnect pressure control switch on the hydropneumatic tank with the starter for the well pump to maintain the desired preset pressure. Furnish and wire in an adjustable range time delay switch equal to Tork E50IT to prevent short cycling of the motor. Timer adjustment range shall be two minutes to one hour in one minute graduations of adjustment and shall be initially set at two minutes.
9. Motorized backdraft dampers on exhaust fans and power roof ventilators shall be connected up to their respective associated motor leads to energize the backdraft damper motor and open the damper when the fan operates. Dampers, operator and transformer if required, will be furnished by the fan supplier. Where the motors are fed from a variable frequency drive controller (VFD) provide a separate branch circuit to serve the dampers from the nearest panelboard (normal or emergency use same type of source as the associated fan motor) with control through the VFD damper control output relay. Coordinate requirements with the VFD Supplier.
10. Each snow melting pump shall be equipped with a magnetic starter with a hand off auto switch. Furnish one Tork E50IT Series (6 hour) timer and wire into the automatic circuit to stop the pump circulation after the preset time has transpired. Timer range shall be adjustable from zero to six hours.
11. Alarm bell and high limit float switch for the deaerator will be furnished by the Division 23. These shall be accepted, mounted and wired, including providing a 120 volt source of current, by the Contractor.
12. Alarm bell for sewage pumps or bilge pumps shall be installed and wired at a location remote from the pumps. Transformer and bell are furnished by the pump supplier.
13. Boiler recirculating pump starters shall be equipped with an auxiliary contact to accommodate an interlock between the boiler and the pump. Wiring on this control shall be by this Contractor.

14. Power supply for heat tapes shall be provided as indicated on the drawings. Heat tapes are furnished under Division 23. Coordinate with Division 23 for detailed location and method of connection; provide ground fault protection of equipment per NEC Article 427.
15. Compactor control panel and remote alarm will be furnished under Division 11. This Contractor shall install the remote alarm, a 120 volt control supply, a three phase power supply and control wiring. Secure drawings from supplier before roughing in.
16. Independently mounted controllers, furnished by others: where starters are furnished by other trades, and are required to be mounted remote from the motor, this Contractor shall accept and mount them and perform all power and control wiring between controls and motors as indicated. Motor controllers equipped with automatic alternators shall have two independent circuits and control sources to preclude loss of operation when one circuit fails.

3.4 Wiring in Hazardous Locations

A. The areas indicated on the drawings and where required by Code are to be considered hazardous locations.

B. All switches, outlet devices, fixtures and wiring to be installed in these areas shall comply with special requirements of the National Electric Code Article 500, Class I, Division 1. Explosion proof devices shall be used throughout.

C. To avoid expense and to minimize the hazards, electrical work shall be so laid out and installed as to require only a minimum of wiring and outlets.

END OF SECTION

26 05 73 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 Scope

A. Provide a protective device coordination study for the new electrical distribution system provided by this project and those portions of the existing electrical power distribution system affected by this project. It is not intended that the entire existing building be included in the study.

B. The study shall include a short-circuit study and equipment-interrupting or withstand evaluation on all portions of the electrical distribution system from the normal and emergency sources of power through the low-voltage distribution systems to the branch circuit panelboard level. All modes of operation shall be thoroughly covered in the study.

C. The study shall include an arc flash risk assessment per NFPA 70E Standard for Electrical Safety in the Workplace including labeling of equipment. Coordinate with the owner for design of the labels provided where existing part of system is labeled. The arc flash risk assessment shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E.

1.2 References

A. Institute of Electrical and Electronics Engineers,

1. IEEE 141 – Recommended Practice for Electric Power Distribution for Industrial Plants
2. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
3. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
4. IEEE 399 – Recommended Practice for Industrial and Commercial Power Systems Analysis
5. IEEE 551 – Calculating Short Circuit Currents in Industrial and Commercial Power Systems
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. National Fire Protection Association,

1. NFPA 70 – National Electrical Code
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.3 Qualifications

A. The short-circuit, protective device coordination and arc flash analysis studies shall be conducted under the supervision and approval of a Registered Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical engineer shall be a full-time employee of the Engineering Services Company.

B. Submit qualifications and background of firm. Submit qualifications of Professional Engineer performing the study.

1.4 Submittals

A. The short circuit and protection device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient data to ensure that the selection of device and characteristics will be satisfactory.

B. The results of the short-circuit, protection device and arc flash risk assessment studies shall be summarized in a final report. Three (3) bound copies of the complete report shall be submitted for owner reference. A disc copy of final analysis shall also be provided.

PART 2 - PRODUCTS

2.1 Studies

A. The Contractor is to furnish short-circuit and protective device coordination studies as prepared by the equipment manufacturer(s) or Engineering Services Company.

B. The coordination study shall be from the utility company's protective device and include all of the electrical protection devices down to and include the largest feeder breaker and motor starter in the 480 volt motor control center, equipment control panels and power distribution panels, the stepdown transformer and branch panelboards.

2.2 Data Collection

A. The Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit and coordination studies and flash analysis shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to ensure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized shall include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. Include fault contribution of existing motors in the study, with motors <50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 Short-Circuit And Protective Device Evaluation Study

A. Use typical conductor impedances based on IEEE Standards 141- latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system, generation system and motor fault contribution characteristics
5. Typical calculations
    a. Fault Impedance
    b. X to R ratios
    c. Asymmetry factors
    d. Motor fault contributors
    e. Short circuit kVA
    f. Symmetrical and Asymmetrical phase-to-phase and phase-to-ground fault currents
    g. Tabulation of calculated quantities and results
6. Tabulations of calculated quantities

7. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic and manual transfer switches
7. UPS primary and secondary terminals and by-pass secondary terminals
8. Branch circuit panelboards
9. Busway
10. Equipment control panels
11. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating
5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.4 Protective Device Coordination Study

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points

9. Pertinent generator short-circuit decrement curve and generator damage point
10. Equipment control panels.
11. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Emergency side distribution overcurrent protection shall be fully coordinated including use of manufacturer's selectivity tables and charts. Circuit breakers models shown on plans are selectively coordinated, manufacturers of equal selectively coordinated equipment shall be supplied at no additional charge.

2.5 Arc Flash Risk Assessment

A. The arc flash hazard risk assessment shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2015, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and equipment control panels) where work could be performed on energized parts.

D. The Arc-Flash Risk Assessment shall include all MV, 480V locations and significant locations in 240V and 208V systems fed from transformers equal to or greater than 45 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Risk Assessment shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 Report Sections

A. Input Data:

1. Motor contribution data, short-circuit reactance of rotating machines with associated X/R ratios
2. Conductor type, construction, size, # per phase, length, impedance and conduit type
3. Bus duct type, size, length and impedance
4. Transformers
5. Generation contribution data (synchronous generator and utility)

6. Aerial line type, construction, conductor spacing, size, # per phase and length
7. Circuit resistance and reactive values

B. Short-Circuit Output Data:

1. Utility three-phase and line-to-ground available contributor with associated x/R ratios
2. Source fault impedance and generator contributions
3. Fault point X to R ratios
4. Asymmetry factors
5. Motor contributions
6. Short circuit kVA
7. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings

1. Phase and Ground Relays:
   a. Current transformer ratio
   b. Current setting
   c. Time setting
   d. Instantaneous setting
   e. Specialty non-overcurrent device settings
   f. Recommendations on improved relaying systems, if applicable
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup
   d. Recommendations on improved trip systems, if applicable

D. Incident Energy and Flash Protection Boundary Calculations

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard risk category
8. Recommendation for arc flash energy reduction

PART 3 - EXECUTION

3.1 Field Adjustment

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the startup and acceptance testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.2 Arc Flash Warning Labels

A. The vendor shall provide a 3.5 in. X 5 in. Thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have a header with the wording, orange header - “Warning, Arc Flash Hazard” or red header - “Danger Arc Flash Hazard”, and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings.

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects and equipment control panel, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided on each side in door/panel.
3. For each low voltage switchboard, one arc flash label shall be provided on each front and rear door.
4. For each switchgear, one flash label shall be provided on each front and rear panel.
5. For medium voltage switches one arc flash label on each front and rear door shall be provided.

E. Labels shall be field installed by the Engineering Service Division of the equipment manufacturer or the Engineering Service company.

3.3 ARC FLASH TRAINING

A. The contractor of the Arc Flash Risk Assessment shall train the owner’s qualified electrical personnel of the potential arc flash risks associated with working on energize equipment (minimum of 4 hours).

END OF SECTION

26 08 00 COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 Refer to specification Section 01 91 00 – Commissioning for the detailed responsibilities of all parties as it relates to the project. All Contractors shall fully participate in the commissioning process including managing their related documentation using the Commissioning Documentation Database described in Section 01 91 00.

1.2 Responsibilities

A. The responsibilities of various parties in the commissioning process are identified in Section 01 91 00. Additional responsibilities related to Division 26 systems, are identified herein.

B. The Construction Manager (CM) shall:

1. Facilitate the coordination of the commissioning work by the CxA. The CM and CxA shall ensure that commissioning activities are being scheduled into the master schedule in the proper sequence.
2. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
3. Ensure that all Contractors execute their commissioning responsibilities according to the Contract Documents and schedule.
4. Attend the commissioning scope meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
5. Observe and witness construction, Construction Checklists, Startup Checklists, Startup Operational Testing, and Functional testing of equipment to be commissioned.
6. Review commissioning progress and deficiency reports / issues log and resolve items in an expeditious manner.
7. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
8. Coordinate the training of owner personnel.

C. Each Contractor shall:

1. Coordinate the commissioning work with the CxA.
2. Execute their commissioning responsibilities according to the Contract Documents and schedule.
3. Attend the commissioning scope meeting(s) and other necessary meetings scheduled by the CxA to facilitate the Cx process.
4. When necessary, observe and witness construction, Construction Checklists, Startup Checklists, Startup, Operational Testing, and functional testing of selected equipment.
5. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.
6. Assist in equipment testing per agreements with Contractors/Sub-Contractors.
7. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for operational and functional testing equipment according to these Contract Documents in the base bid price to the Contractors/Sub-Contractors.
8. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
9. Review commissioning progress and deficiency reports and resolve items in an expeditious manner.
10. Resolve the non-compliance and design deficiencies identified in all phases of commissioning.
11. Coordinate the training of Owner personnel for the systems provided under this contract.

12. Prepare O&M manuals, according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
13. Review test procedures for equipment started up by factory representatives.
14. Provide the necessary information for their trade as outlined in Section 01 91 51.

1.3 Division 26 Systems to be Commissioned are as follows:

A. The following systems shall be commissioned in this project:

1. Electrical
   a. Interior Lighting Control – Daylighting sensors
   b. Network Lighting Controls
   c. Exterior Lighting Controls
   d. Generator

PART 2 - PRODUCTS

2.1 Test Equipment

A. All standard testing equipment required to perform startup and initial checkout, operational test and required functional performance testing shall be provided by the Contractors for the equipment being commissioned.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, shall be provided by the Contractors.

C. All testing equipment shall be of sufficient quantity, quality and accuracy to test and/or measure system performance. All equipment shall be calibrated within the last year, and according to the manufacturer's recommended intervals, and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

D. The Contractor shall provide written documentation to the CxA that the Contractor's staff has been trained on the proper use and application of any testing equipment.

E. Functional Performance Testing Electrical Metering Equipment

1. Electrical metering provided by the Contractor shall provide waveform capture for voltage (all phases of equipment tested), amperage (all phases of equipment tested), frequency (all phases of equipment tested), and harmonics (all phases of equipment tested, fundamental through 49th). All waveforms shall be recorded for specific tests as directed by the CxA.
2. These recordings shall be downloaded and put into a Microsoft Word or Excel document, for the incidents required by the CxA, and transmitted via the Cx documentation database to the CxA within 5 business days of the recording. The Word or Excel format shall provide, at a minimum, waveform capture 1 second before the incident, the duration of the incident and 1 second after the incident, unless specified by the CxA to be otherwise. Continuous metering may be required as directed by the CxA.
3. Each unitary meter shall be a Fluke 1750 with accessories or RPM 1656 with accessories or pre-approved equal, and shall be provided and maintained in sufficient quantities to accomplish the execution of the Electrical Functional Testing (input and output), in a reasonable time frame and for multiple simultaneous tests as directed by the CxA.
4. Electrical testing companies regularly engaged in testing and metering electrical equipment as required under this contract, may be hired by the Contractor which shall be included in the Contractor bid price.

5. The Electrical Contractor shall provide written documentation to the CxA that the Contractor's staff has been trained on the proper use and application of the metering, if a separate testing company is not utilized.

PART 3 - EXECUTION

3.1 Construction Checklists, Start-Up Checklists, and Initial Checkout Documentation

A. The following procedures apply to all equipment to be commissioned as listed Systems to be Commissioned. Some systems that are not comprised of actual dynamic machinery may have very simplified CCs, SCs and startup.

B. Startup and Initial Checkout Plan. The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed startup plans for all equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for construction and startup checklists are identified in the commissioning orientation meeting and in the checklist forms.

1. The CxA provides these checklists and tests to the Contractors. The Contractor determines which trade is responsible for executing and documenting the tests.
2. The Contractor responsible for the purchase of the equipment develops the full startup plan by combining (or adding to) the CxA's checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. Where required, the equipment shall be started up by factory representatives. The CxA shall be notified a minimum 48 hours prior to equipment startup.
3. The Contractor submits the full startup plan to the CxA for review.
4. The CxA reviews the procedures and the format for documenting them, noting any procedures that need to be added.

C. Execution of Construction and Startup Checklists, and Startup

1. The Contractors schedule startup and checkout with the CM and CxA. The completion of the construction and startup checklists, startup and checkout is the responsibility of the Contractors. When checking off construction and startup checklists, signatures required of other Contractors for verification of completion of their work.
2. The CxA shall observe, at minimum, the procedures for each piece of primary equipment. In no case shall the number of units witnessed be less than the contractual agreement on any one building.
3. The Contractors shall execute startup and provide the CxA with a signed and dated copy of the completed startup, and Construction and Startup tests and Checklists.
4. Only individuals that have direct knowledge and witnessed that a line item task on the construction and startup checklist was actually performed shall initial or check that item off.

D. Deficiencies, Non-Conformance and Approval in Checklists and Startup

1. The Contractors shall clearly list any outstanding items of the initial startup and construction and startup procedures that were not completed successfully, and any completed corrections, at the bottom of the procedures form. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the Contractor or CM. The CxA shall work with the Contractors to correct and

retest deficiencies or uncompleted items. The CxA shall involve the CM and others as necessary. The installing Contractors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated startup report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and start-up of each system.

3. Items left incomplete, which later cause deficiencies or delays during functional testing will result in incidental damages to the responsible party.

3.2 Functional Performance Testing (FT)

A. Objectives and Scope. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. During the testing process, areas of deficient performance are identified and corrected, improving the operation and functionality of the systems.

B. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, part- and full-load systems, steady state, reaction to changes in operating conditions and emergency conditions) where there is a specified system response. Verifying each step in the sequences of operation is required. Proper responses to such modes and conditions as power failure, equipment failure, etc. shall also be tested.

C. Development of Test Procedures. Before test procedures are written, the CxA shall be provided by the Contractor all documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor responsible to execute a test shall provide appropriate assistance to the CxA in developing the test procedures. Prior to execution, the CxA shall provide a copy of the test procedures to the Contractors who shall review the tests for feasibility, safety, equipment and warranty protection.

The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.

The test procedure forms developed by the CxA shall include (but not be limited to) the following information:

1. System and equipment or component name(s)
2. Equipment location and ID number
3. Unique test ID number, and reference to unique construction and startup checklist and startup documentation ID numbers for the piece of equipment
4. Date
5. Project name
6. Participating parties
7. A copy of the specific sequence of operations or other specified parameters being verified
8. Required pre-test field measurements
9. Instructions for setting up the test
10. Special cautions, alarm limits, etc.
11. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
12. Acceptance criteria of proper performance with a check box to allow for clearly marking whether or not proper performance of each part of the test was achieved
13. A section for comments

14. Signatures and date block for the CxA

D. Test Methods

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using recording type Power Line Disturbance Monitors (PDM). The CxA may substitute specified methods or require an additional method to be executed, other than what was specified. The CxA shall determine which method is most appropriate for tests that do not have a method specified.
2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Simulated Electrical Loads. Using a resistive load bank which creates a simulated electrical load to test and calibrate equipment is generally recommended over using building electrical load to simulate electrical maximum loading conditions. Both load bank and building load together may also be used. The cost of any load bank testing shall be included in the Contractor's bid price including an appropriate number of days to cover the testing schedule. Re-testing shall also be provided as required.
4. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.
5. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. These verifications shall be completed during construction and startup testing.
6. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor executing the test shall provide all necessary materials, system modifications, metering (PDM's), load banks, personnel, etc. to produce the necessary loads, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Contractors shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
7. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference**. It is noted that no sampling by Contractors is allowed in construction and startup checklist execution**.

E. Coordination and Scheduling. The Contractors shall provide sufficient notice to the CxA regarding their completion schedule for the construction and startup checklists and startup of all equipment and systems. The CxA shall schedule functional tests through the CM and affected Contractors. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractors shall execute the tests.

In general, functional testing is conducted after construction checklists, startup testing, and pre-functional testing has been satisfactorily completed. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.

F. Test Equipment. Refer to Part 2 for test equipment requirements.

G. Problem Solving. The CxA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, Contractors and A/E.

H. Prior to indicating that equipment or systems are ready for functional testing, the Contractor shall have independently completed the pre-functional test with successful result.

3.3 Documentation, Non-Conformance and Approval of Tests

A. Documentation. The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose using the Cx Documentation Management Database. Prior to testing, these forms are provided to the CM and Contractor for review. The CxA shall include the completed forms in the final Cx report.

B. Non-Conformance

1. The CxA shall record the results of the functional test on the procedure or test form using the Cx documentation database. All deficiencies or non-conformance issues shall be noted and reported to the CM on a standard non-compliance form/issues log.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution shall be documented on the procedure form.
3. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing Contractors.
    a. When there is no dispute on the deficiency and the Contractors accepts responsibility to correct it:
        1) The CxA documents the deficiency and the Contractors response and intentions and they go on to another test or sequence. The Contractors corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
        2) The CxA reschedules the test and the test is repeated. See sub-item 3.5.B.4..
    b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
        1) The deficiency shall be documented on the non-compliance form with the Contractors response and a copy given to the CM and to the Contractors representative assumed to be responsible.
        2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the owner’s representative.
        3) The CxA documents the resolution process. The CxA will test equipment once and provide one re-test, additional cost associated with further required re-testing of the same equipment shall be borne by the responsible Contractors.
        4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.
4. Cost of Retesting
    a. The cost of the CxA for the Contractor/Sub-Contractor to retest a construction and startup of functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the CM.
    b. Owner will compensate CxA / A/E for attending and directing additional testing.
    c. Owner will deduct additional testing compensation from final payment due to Contractor.
    d. For a deficiency identified, not related to any construction and startup checklist or startup fault, the following shall apply: The CxA and CM shall direct the retesting of the equipment once at no “charge” to the Owner for their time. However, the CxA’s and CM’s time for a second retest shall be charged to the Contractor, who may choose to recover costs from the responsible Contractor/Sub-Contractor/vendor.

e. The time for the CxA and CM to direct any retesting required because a specific construction and startup checklist or startup test item, reported to have been successfully completed, but determined during functional testing to be faulty, shall be in the form of incidental damages to the CM, who may choose to recover costs from the party responsible for executing the faulty construction and startup test.
f. Refer to the sampling section of Para. 3.2 for requirements for testing and retesting identical equipment.

5. The Contractors shall respond in writing to the CxA and Owner at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
6. The CxA retains the original non-conformance forms until the end of the project.
7. The Contractors shall not consider any required retesting by any Contractors a justified reason for a claim of delay or for a time extension.

C. Failure Due to Manufacturer Defect. If 10 percent, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units shall be considered unacceptable. In such case, the Contractors shall provide the Owner with the following:

1. Within one week of notification, the Contractors or manufacturer's representative shall examine all other identical units, making a record of the findings. The findings shall be provided to the CM within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractors shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. The CM shall determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples of the proposed solution shall be installed by the Contractors and the CxA shall be allowed to test the installations for up to one week, upon which the CM shall decide whether to accept the solution.
5. Upon acceptance, the Contractors shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

D. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA. The CxA recommends acceptance of each test to the CM using a standard form. The CxA gives final approval on each test using the same form, providing a signed copy to the Contractor.

3.4 Operation and Maintenance Manuals

A. Standard O&M Manuals

1. The specific content and format requirements for the standard O&M manuals are detailed in specifications.

3.5 Training of Owner Personnel

A. The CM and each Contractor shall be responsible for training and scheduling and ultimately ensuring that training is completed.

3.6 Deferred Testing

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the CxA. These tests shall be conducted in the same manner as the original tests as soon as possible. Services of necessary parties shall be negotiated. Equipment that does not initially pass deferred functional testing shall have the warranty start date adjusted to date of passing test completion.

B. Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests shall be executed, documented and deficiencies corrected by the appropriate Contractors, with facilities staff and the CxA witnessing. Equipment that does not initially pass seasonal functional testing shall have the warranty start date adjusted to date of passing test completion. Any final adjustments to the O&M manuals and as-builts due to the testing shall be made.

3.7 Written Work Products

A. The commissioning process generates a number of written work products described in various parts of the specifications. In summary, the written products are:

Product	Developed By
Final commissioning plan	CxA
Cx Meeting minutes	CxA
Commissioning schedules	CxA with CM
Equipment documentation submittals	Responsible Installing Contractors
Sequence clarifications	Responsible Installing Contractors and A/E as needed
Construction and startup checklists	CxA (included in specifications)
Startup and initial checkout plan	Responsible Installing Contractors and CxA (compilation of existing documents)
Startup and initial checkout forms filled out	Responsible Installing Contractors
Commissioning Progress Record	CxA
Deficiency reports	CxA
Operational Test Form	Responsible Installing Contractors
Functional test forms	CxA
Filled out functional tests	CxA
O&M manuals	Responsible Installing Contractors
Commissioning record book	CxA
Overall training plan	CM
Specific training agendas	Responsible Installing Contractors
Final commissioning report	CxA

END OF SECTION

26 09 13 ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 System Description

A. Furnish and install a complete Power Monitoring System (PMS) as detailed on the drawings and as described in this specification. The system is defined to include, but not be limited to, remote devices for monitoring, control and protection, device communication interface hardware, inter-communication wiring, personal computer workstation(s), software, remote touchscreen displays, ancillary equipment, start-up, training services and ongoing technical support.

B. The PMS shall utilize Ethernet as the high-speed backbone network that supports direct connection of the personal computer workstation(s) and monitored devices anywhere on the network.

C. Each Personal Computer Workstation (PCW) connected to the network shall have equal access to information provided by the power monitoring devices for centralizing data display, data logging, alarming, event recording, and other power monitoring operations. Each PCW shall be independent of the other PCWs with its own software to allow the user to retrieve and configure the information based on the user's needs.

D. The high-speed network shall allow direct access to data provided by the power monitoring devices for implementing automatic control. Note that the system shall be capable of automatic control but it will not be utilized for remote control purposes in this project phase.

E. Application software for central server as well as personal computer workstations shall be provided.

F. The Building Local Area Network shall be interfaced with the PMS to allow remote viewing of Web page based information throughout the Owner's Intranet, as well as the capability for remote viewing over the Internet. Provide technical support personnel to meet and coordinate with Owner's IT personnel to coordinate this interface.

G. Wall mounted color flat touchscreen display unit(s) shall allow personnel to select Web page based information displaying real time electrical parameters of the system at selected locations.

H. System shall be user configurable to allow customized data tables, alarm points, graphics and detailed event instructions. System shall be capable of initiating e-mail, pager and telephone communications to selected personnel as programmed for specific alarms or other system events.

I. System shall have programmed links to online equipment user / operational manuals, equipment maintenance information and procedural sequence of event steps in response to alarms.

J. System shall have the capacity and capability to easily integrate data from the facility's building automation system.

1.2 Quality Assurance

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, BICSI standards, applicable NEC and OBC Code Sections.

B. All Power Meters and Circuit Monitors shall be UL 508 Listed, CSA approved, and have CE marking. They shall also have certified revenue accuracy as per ANSI C12.16.

C. The system shall comply with the applicable portions of ANSI/IEEE 802.3 and NEMA standards. In addition, the control unit shall comply with FCC Emission Standards specified in Part 15, Sub-part J for Class A application.

D. The manufacturer shall demonstrate the system is not a prototype and that similar systems have been field installed and successfully operated for at least five years. The PMS vendor shall have full responsibility for insuring that the PMS system performs as specified.

E. All products shall not violate any U. S. patents.

F. The PMS vendor shall be ISO 9000 registered to demonstrate quality compliance.

1.3 Submittals (Including proposal submittals as noted)

A. Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:

1. System description including an overview of the system provided with detailed description of system architecture. A customized system diagram showing location of computers, repeaters, gateways and assemblies/devices to be connected to the system, as well as types of wiring required (twisted pair, coax, fiber), and a general layout of wiring referencing the specific building layout shall also be part of this description. Submit this item with the proposal.
2. Bill of material including a complete listing of all hardware, software, software licenses, training, and startup services being supplied under this contract. Submit this item with the proposal.
3. Hardware and software description shall be provided in detail for all communications hardware and software, including sensor devices and gathering data to be transmitted over the network and master display unit. This description will include a list of all the communicating devices to be connected to the network.
4. Typical software screen displays shall be provided in printout form and electronics file on CD for sample viewing on user monitors.
5. Indicate electrical characteristics and connection requirements. The PMS drawings shall show all PMS components including necessary component dimensions, type, size and weight; location of conduit entry and exit; single line diagram indicating external wiring requirements. Drawings shall identify terminal blocks used for interconnections and wire type to be used.
6. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.

1.4 Related Sections

A. 26 13 13 – Medium Voltage Circuit Breaker Switchgear (5 KV/15 KV class)

B. 26 11 16 – Secondary Unit Substations

C. 26 23 13 – Paralleling Low Voltage Switchgear

D. 26 24 13 – Distribution Switchboards (Below 600 Volts)

E. 26 43 13 – Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits

PART 2 - PRODUCTS

2.1 The PMS shall be similar in quality and performance to the Square D PowerLogic System, utilized as the basis of design herein for establishing equipment criteria and system functionality. Equal by Eaton or Siemens. Equipment supplier shall have a service organization within 50 miles of the project site. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of these specifications.

2.2 Primary Computer Workstation/Server

A. Provide a primary computer workstation/server consisting of a personal computer, 21 inch flat screen super VGA color monitor, and color inkjet printer. Personal computer/server shall be manufactured by DELL or approved equal having the following minimum features:

1. Pentium i5 processor with 1 GB SDRAM, 70 GB hard disk drive (RAID 5 / triple redundancy).
2. Windows 7 operating system. Microsoft Internet Explorer Version 6.0 or higher as currently available.
3. Windows 7 server.
4. Quantity of COM ports, parallel ports, printer ports, and USB ports to support the system configuration.
5. Auto-reboot capability after a power failure.
6. 16 bit PCI sound card with built-in stereo speakers.
7. 10/100 Base switched Ethernet Card.
8. 32X CD R/W Drive.
9. 32X DVD R/W Drive.
10. 3.5 inch floppy disk drive.
11. 56K Modem
12. 101 Key Microsoft keyboard and optical 3 button USB mouse with scroll wheel.
13. 1000 VA UPS with 15 minutes of full power back-up.

B. The PMS application client application shall be capable of running on Microsoft Windows 7.

C. Provide optional add alternate costs for:

1. Rack mounted Server instead of PC based workstation/server. Note that workstation would still be required, server would physically be located in a different room.
2. Independent Back-up Resources including 40/80GB DLP-4 Tape Drive with compression capability and back-up software by Tivolli.

2.3 PMS Network

A. The PMS Network shall be a dedicated Ethernet network, utilizing MODBUS TCP/IP protocol communicating at 10/100 MB. The physical media used to form the network shall be multi-mode fiber optic cabling and UTP Cat 6 copper for secondary commence action cabling. Any devices connected to the PMS Network shall be equipped with an Ethernet communication card and communicate at 10/100 MB. Provide network hubs, routers, switches, media converts, etc. as shown on the drawings and as required for the installation.

B. Connecting and Networking of Power Monitoring Devices

1. All data stored in the Power Monitoring Devices shall be accessible to external devices by means of RS-485 serial communications.
2. It shall be possible to connect from one communications port to another (daisy-chain) such that up to 32 Power Monitoring Devices may be connected to form a continuous communications link extending up to 10,000 feet. Note: Provide multiple daisy chain connection routes within the network system, one large continuous daisy chain is not acceptable.

3. Communications links shall be compatible with the RS-485 multi-drop communications standards.
4. Communication rates on the links shall be adjustable up to 38.4 K baud to provide acceptable throughput of power monitoring device data.
5. It shall be possible to connect an unlimited number of communications links into a large network using Ethernet hubs to form a high-speed power monitoring and control network.

C. Network Information

1. The PMS shall be connected by means of Ethernet as the high-speed backbone network to the building LAN. Provide an appropriate interface as coordinated with Owner's IT. The entire PMS shall appear as just one IP address on the Owner network.
2. The high-speed network shall consist of a PowerLogic Power Server that allows computers, display panels and other higher level or sub-networks to access the electrical data being gathered by the Circuit Monitors and other remote devices.
3. It shall be possible to add an unlimited number of Personal Computer Workstations (PCWs) to the high speed network. Addition of a new PCW shall not require any modification to any existing PCWs. Adding PCWs shall require only a simple network tap; extensive rewiring or wiring to each group of monitoring devices shall not be required.
4. The system shall alarm on detected faults in communication servers or remote devices.
5. The system shall have the capability of being programmed and modified online. It shall not be necessary to shut down any part of the system during programming operations.

2.4 Central Power Server Device / Web Browser Clients

A. The PMS shall include a central Power Server computer, complete with web-based PMS Application Software as described in Article 2.5 of this specification, and shall be located as designated on the project drawings. It shall be pre-configured with all software, configuration files, and one-line drawings by the vendor and ready to connect and operate when delivered to the job site.

B. Hardware Requirements

1. The PMS system shall include one (1) factory supplied Power Server device capable of displaying and storing information from all Circuit monitors and remote devices.
2. Server shall support RAID array for hard drive storage and support hot swappable features. Server equipped with a 10/100 network card and appropriate server/client software to connect to the LAN.
3. Server shall be fully functional with all required software and drivers including software for System Administration, Database Management, Communications Routing, etc. as required for a fully operational system.
4. The Server shall be PowerLogic Power Server model WebSuite (latest version) including complete graphics package.
5. It shall be possible to operate networked computer workstations (PCW) and remote touchscreen displays in a web browser environment to allow data sharing and viewing with/on any computer on the network with a Microsoft Internet Explorer web browser (version 6.0 or higher as currently available). Each workstation / remote display shall have complete access to all PMS information simultaneously.

C. Software Requirements

1. The manufacturer shall supply PMS application software which provides the operator user friendly web page access to all Circuit monitor data, breaker/contactor/switch status, communication alarms, captured waveforms, logged data and all other remote devices including but not limited to switchgear circuit monitors.

2. Central PMS Server application software shall provide unlimited access to Custom Graphic web pages with dynamic data display. Custom Graphic web pages shall be user configurable within the PMS system.
3. Central PMS Server application software shall provide unlimited access to HTML based Reports. The Central Server software will organize these HTML Reports into links on the PMS main web page. HTML Reports shall be user configurable within the PMS system.
4. The Power Server WebSuite shall be capable of being remotely administrated using a Microsoft NetMeeting session. The NetMeeting session will be utilized primarily by System Administrators to configure the PMS system.
5. Vendor to provide all required Microsoft licenses for central Power Server WebSuite.

2.5 PMS Application Software

A. General

1. The PMS shall be supplied with user-friendly application software suitable for operation on Power Server WebSuite which serves as central server by monitoring the devices in the system, recording events, indicating alarm conditions, and displaying and logging device data.
2. The PMS shall provide all data to Users via a standard Microsoft Internet Explorer web browser (version 6.0 or higher currently available).
3. The software shall be designed specifically for power monitoring. The vendor shall provide information detailing if the software and/or graphics have been developed by the manufacturer of the power monitoring system devices or by a third party vendor. In the event of a third party vendor provide description, length of association and current contractual agreements between the vendor and the third party.
4. The vendor shall describe the procedure to be used to allow the software to support additional monitoring devices at a future date, including graphical changes and/or additions. The description shall be in sufficient detail to allow the user to make the modifications without vendor support.
5. The software shall be configured, not programmed. All software shall be configured by the vendor and delivered ready to use. This configuration shall include preparation of all graphics, displays, and interactive one-line diagrams required as a part of this project.
6. Any development keys or programming tools needed by the user to make modifications to the screens, interactive one-line diagrams, or displays shall be provided by the vendor.
7. The software vendor shall offer regularly scheduled classes to provide instruction on using application software and associated monitoring devices to manage and maintain a PMS.
8. Power Server WebSuite functionality
    a. Shall support up to 1000 PMS devices, and poll all as required.
    b. Shall permit device setup including configuration of circuit monitor data and waveform logs. Shall allow the user to define circuit monitor alarms and configure circuit monitor relay operation.
    c. Shall allow devices and quantities to be organized into logical groups (function, location, department, etc.). Groups shall be user defined, each group having a unique name.
    d. Shall provide resets of all supported devices. Shall allow resets by device or by group of devices.
    e. Shall include an on-line, context sensitive help system.
    f. Shall provide Alarm / Event reporting
        1) Alarms shall be user defined pick-ups and drop-outs.
        2) Shall include pre-defined system alarms.
        3) Ten severity levels for analog and digital alarm conditions shall be supported.
        4) Each severity level shall provide user selected indication including audible, visible, and/or required acknowledgment.
    g. Shall display digital status inputs.

h. Shall accept electrical/non-electrical pulse inputs that can be scaled and used as any other metered quantity including real-time displays, alarm functions, and logging and trending functions.
i. Shall provide real time, user friendly tabular displays of electric system information.
j. Shall provide equipment ratings documentation capability.
k. Shall provide the capability to report sums, differences, and percentages of real-time readings. This data shall be available for real-time reporting, logging and trending, and alarm functions.
l. Shall retrieve and display tables of historical data recorded over time.
m. Shall provide time trend plots of historical data over time.
    1) Shall be possible to overlay on the same plot information from multiple circuit monitors.
    2) Shall be possible to plot only a portion of the total data available.
    3) The user shall be able to specify the beginning and ending date and time of the data to be plotted.
n. Shall retrieve and display data and alarm and event logs created and stored in circuit monitors.
o. Shall capture and log waveforms and harmonic information based on user specified criteria.
    1) Shall provide graphical waveform displays for the phase voltages, phase currents, and residual current monitored by circuit monitors. Additional displays shall include overlay of 3 phases of voltage, overlay of 3 phases of current, and each phase voltage and current overlaid.
    2) Shall provide the capability to integrate waveform viewer into third party software applications.
    3) The following information shall be calculated and displayed based on minimum of 4 cycles of data:
        a) Total Harmonic Distortion (THD), rms magnitudes, peak values, Crest Factors (CF), and magnitudes of the individual harmonics.
        b) All harmonics calculations shall be based on samples covering multiple cycles in order to reduce inaccuracies caused by sampling discontinuities.
    4) Shall retrieve, display, and waveform captures from circuit monitors.
p. Shall allow user to create custom tables for viewing electric system information in convenient formats. Custom tables shall be easily modified as need arises.
q. Shall include a task manager scheduling capability that provides automated program operations for repetitive tasks. Such tasks shall include scheduled resets, device log and file retrieval, generating and printing reports, launching executables, sending email, and activating beepers. Frequency and execution of automated tasks shall be user defined. **A sample task would be to e-mail a user defined load table to selected personnel on a weekly basis.**
r. Shall provide real time, user friendly bar chart and meter displays of electric substation service information.
s. Shall allow creation of custom real time trend plots, charts, and meter panels for viewing electric system information in convenient formats. Custom displays shall be easily modified as the need arises.
t. Shall allow user to develop reports for any displayable electrical system information.
    1) Shall provide options to simplify routine printouts of various data for standard reports.
    2) User shall be allowed to modify reports.
u. Shall log PMS data to non-volatile memory at user specified intervals.
v. Shall be capable of exporting logged data to other file types used by other common commercially available software products.
w. After power loss and restoration shall restart automatically, go on-line and resume logging and alarming.

9. Power Server WebSuite HTML Reports
    a. Utilizes “Wizard” based Report setup and scheduling. Reports do not require any programming – configuration using standard dialog screens only.
    b. HTML format reports are generated on a scheduled basis, or upon demand.

c. The following Reporting capability shall be provided:
   1) Cost Allocation Report (including cost per kWh and kWD) showing dollars in a tabular format, or showing usage in a graphical format. Utilize utility rate structure.
   2) Historical Trend plots (up to 14 devices shown simultaneously)
   3) Historical Data tables
   4) Alarm Analysis Report (showing Trend plot with Alarm limits)
   5) Statistics (Min, Max, Average for a Trend Plot)
   6) Histogram Reports

10. Power Server WebSuite Interactive Graphics Displays
    a. The software shall display dynamic information collected by the network server from the power monitoring devices on custom drawings.
    b. Interactive Graphics web pages shall be provided to depict as a minimum the following customized pages:
       1) Building Floor Plan indicating Equipment Locations with tags for alarm indication and data viewing.
       2) Overall Block Diagram of Distribution.
       3) Three (3) one line diagrams as per the drawings.
       4) Front Elevation view of each switchgear (total of 4) and associated digital picture image.
       5) Additional user defined web page to be determined after system is functional and online.
    c. Shall be accessible wherever needed via Internet Explorer web browser on any PC in the monitoring system connected to the server via LAN, WAN, or modem.
    d. It shall be possible to display any of the quantities available from the power monitoring devices or other remote devices in the location, size, and color selected by the user.
    e. The software shall provide the ability to perform executables and launch other programs using hyperlink buttons, or as a scheduled task.
    f. The Interactive Graphics shall allow the user to zoom, scale, and scroll the drawings to the desired degree of magnification.
    g. The software shall be capable of displaying status of circuit breakers (open/closed/tripped), status of transformer fans (on/off), transformer coil and motor temperatures and other information available on the PMS network. The data shall be available in multiple formats value blocks, meters, and bar charts.
    h. From within any drawing the user shall have the ability to link and display drawings in a hierarchical fashion to allow quick access to related drawings.
    i. Analog functions blocks shall be included to display the condition (e. g. high, low, or alarm) of any metered quantity such as current, voltage, temperature, etc.
    j. Components shown on one-line diagrams shall be color-coded based on the on/off status signals from the device.
    k. Vendor shall supply custom graphic screens based on user supplied drawings.
    l. Optional animated graphical display components shall be available if selected by the Owner.
    m. One line diagrams shall be color-coded to indicate power flow.

2.6 Priority Support / Software Version Agreement

A. The manufacturer shall include a Software Service Agreement which provides the customer with software upgrades for the software specified above as they are available, for three (3) years. Upgrades shall be provided for all components of the initial installation. The 3-year period shall commence from the date of final Owner/Engineer acceptance of the initial system installation.

B. The manufacturer shall include a dedicated PMS Priority Technical Support center.

C. The PMS Support Center will provide remote support via modem to assist User in troubleshooting, upgrading, and configuring the PMS system.

D. The Priority Support package will include one 2-for 1 training coupon per year (over the 3 year period), allowing the User to send a second person to a factory sponsored training course at no additional cost. Include in the proposal, the cost for the first year training and state the cost for years 2 and 3.

2.7 Power Metering / Monitoring Devices

A. Provide the following power metering/monitoring devices as indicated on the drawings and specified herein.

B. Circuit Monitors (Square D CM4000)

1. Circuit monitor shall be securely mounted within the switchgear or in the case of existing equipment (where noted) in a NEMA 1 hinged enclosure, with separately mounted control/display panel.
2. Electronic circuit monitors shall provide true rms metered values. Information provided by each circuit monitor shall include frequency, temperature, current, demand current, voltage, real power, reactive power, apparent power, demand power, predicted demand power, power factor, accumulated energy, accumulated reactive energy, total harmonic distortion (THD) of each current and voltage, and K-factor of each current.
3. The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 255th harmonic (based on fundamental of 50/60 Hz).
4. The Circuit Monitors shall be rated for an operating temperature range of -25 degrees C to 70 degrees C and have an overcurrent withstand rating of 500 amps for 1 second.
5. All setup parameters required by the Circuit Monitors shall be stored in nonvolatile memory and retained in the event of a control power interruption.
6. The Circuit Monitors shall accept metering inputs of up to 600 VAC direct connection or from industry standard instrument transformers (120 VAC secondary PTs and 5 A secondary CTs). Connection to 480Y/277 VAC circuits shall be possible without use of PTs. Provide all required devices (CT's and PT's) to connect to the system.
7. Any Circuit Monitor may be applied in three-phase, three- or four-wire systems. A fourth CT input shall be available to measure neutral or ground current. If the fourth CT is not used, then a residual current shall be calculated by vectoral addition of the phase currents. In four-wire connections the Circuit Monitor shall utilize the circuit neutral common reference and not earth ground, to provide metering accuracy.
8. The Circuit Monitor shall operate properly over a wide range of control power including 100-305 VAC or 100-300 VDC. Connections to 18-60 VDC shall also be available.
9. Ride through capability shall be available for backup control power for up to 2 seconds.
10. The Circuit Monitor display shall allow the user to select one of three languages to view on the screen: English, French, or Spanish. The Circuit Monitor display shall also allow the user to select a date/time format and the ability to create additional screens for user-specified views and/or custom quantities without overwriting existing standard screens. The Circuit Monitor display shall provide local access to the following metered quantities as well as the minimum and maximum value of each instantaneous quantity since last reset of min/max:
    a. Current, per phase rms, 3-phase average and neutral (if applicable)
    b. Voltage, phase-to-phase, phase-to-neutral, and 3-phase average (phase-to-phase and phase-to-neutral)
    c. Real power, per phase and 3-phase total
    d. Reactive power, per phase and 3-phase total
    e. Apparent power, per phase and 3-phase total
    f. Power factor, 3-phase total and per phase
    g. Frequency
    h. Demand current, per phase and three phase average
    i. Demand real power, three phase total
    j. Demand apparent power, three phase total
    k. Accumulated Energy, (MWh and MVARh)
    l. THD, current and voltage, per phase

m. K-factor, current, per phase
n. Reset of the following electrical parameters shall also be allowed from the Circuit Monitor display:
    1) Peak demand current
    2) Peak demand power (kW) and peak demand apparent power (kVA)
    3) Energy (MWh) and reactive energy (MVARh)
o. Setup for system requirements shall be allowed from the Circuit Monitor display. Setup provisions shall include:
    1) CT rating
    2) PT rating
    3) System type [three-phase, 3-wire] [three-phase, 4-wire]
    4) Demand interval (5-60 min.)
    5) Watt-hours per pulse
p. The Circuit Monitor shall provide a hardware security switch to protect all revenue related metering configuration from unauthorized/accidental changes. The Circuit Monitor shall support the use of a wire seal to further deter inadvertent configuration changes and provide visual tamper indication.
q. For ease in operator viewing, two displays are offered for local viewing of Circuit Monitor data. The liquid crystal display (LCD) shall include backlighting. The enhanced vacuum fluorescent display (VFD) shall be automatically activated by a proximity sensor as the operator approaches.

11. The Circuit Monitor shall communicate via RS-232, RS-485, and Ethernet simultaneously.
12. The Circuit Monitor shall provide Modbus communications using Modbus TCP via an Ethernet network at 10/100Mbaud using UTP or Fiber connections. The Circuit Monitor shall provide the capability to communicate to 31 additional Modbus devices existing on RS-485 daisy chains and report data back to the PMS application software or across the Ethernet network to other software applications.
13. The Circuit Monitor display shall provide a RS-232 communications port on board the metering module as well as an IR RS-232 communications port located on the display. The display port shall be completely accessible during normal operation and shall not require exposure of the operator to life-threatening voltage when in use. The operator shall be able to quickly connect a small Personal Computer (PC) to either the module port or the display port without use of tools or splices. Both the metering module port and the display port shall have all of the communication functionality of the standard hard-wired port. When a connection is made to either the metering module port or the display port, the Circuit Monitor shall continue simultaneous operation of all communication ports associated with the Circuit Monitor.
14. It shall be possible to field upgrade the firmware in the Circuit Monitor to enhance functionality. These firmware upgrades shall be done through either the display port or communication connection. No Circuit Monitor disassembly or changing of integrated circuit chips shall be required. It shall not be necessary to de-energize the circuit or the equipment to upgrade the firmware.
15. The following metered values as well as the minimum and maximum instantaneous readings since last reset shall be communicated by the Circuit Monitor:
    a. Frequency
    b. Temperature
    c. Current, per phase rms and neutral (if applicable)
    d. Current, 3-phase average rms
    e. Current, apparent rms
    f. Voltage, phase-to-phase and phase-to-neutral
    g. Voltage unbalance, phase-to-phase and phase-to-neutral
    h. Power factor, per phase
    i. Power factor, 3-phase total
    j. Real power, per phase and 3-phase total
    k. Reactive power, per phase and 3-phase total
    l. Apparent power, per phase and 3-phase total
    m. Demand current, per phase and three-phase average

n. Demand real power, three-phase average
o. Demand reactive power, three-phase average
p. Demand apparent power, three-phase average
q. Accumulated energy, (MWh, MVAH, and MVARh)
r. Reactive energy, (VARh by quadrant)
s. Total Harmonic Distortion (THD), voltage and current, per phase
t. K-factor, per phase

16. The following demand readings shall be reported by the Circuit Monitor:
    a. Average demand current, per phase
    b. Peak demand current, per phase
    c. Average demand for real power, reactive power, and apparent power
    d. Predicted demand for real power, reactive power, and apparent power
    e. Peak demand for real power, reactive power, and apparent power
17. Each Circuit Monitor shall be capable of receiving a broadcast message over the communications network that can be used to synchronize demand calculations by several Circuit Monitors. This message need not be addressed specifically to any one Circuit Monitor.
18. The following energy readings shall be reported by the Circuit Monitor:
    - Accumulated energy
    - Accumulated reactive energy
    - Accumulated apparent energy
    - Reactive energy by quadrant

    a. For real and reactive energy reported values, separate totals for energy flow in each direction shall be kept, as well as an arithmetic sum.
    b. Each Circuit Monitor shall be capable of operating a solid state KYZ output relay to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations.
19. All Circuit Monitors shall include Waveform Capture capability for current and voltage inputs. Two types of waveform capture available for response to an alarm condition.
    a. The first type “Disturbance Monitoring” shall support the following resolutions, with user defined 2-10 pre-event cycles.

Samples per Cycle (Resolution)	Max Duration - continuous capture
16	915 cycles
32	457 cycles
64	228 cycles
128	114 cycles
256	57 cycles
512	28 cycles

    b. The second type “Adaptive Waveform Capture” shall offer variable resolution of continuous waveform recording as shown in the table below. The Circuit Monitor shall be capable of triggering the Adaptive Waveform Capture on the occurrence (pickup) of an event and shall continue recording until the event ends (dropout) for up to the maximum duration shown. If the event returns to normal prior to the maximum duration, the Circuit Monitor will end the Adaptive Waveform capture. This Adaptive feature will capture a waveform for the entire event, while efficiently manage waveform memory storage requirements.

       Adaptive Waveform capture will detect the Adaptive Waveform capture shall be user selectable as follows:

Samples per Cycle (Resolution)	Max Duration - continuous capture
16	110 seconds (6,600 cycles)
32	55 seconds (3,300 cycles)
64	27 seconds (1,620 cycles)
128	13 seconds (780 cycles)
256	6 seconds (360 cycles)
512	3 seconds (180 cycles)

c. Circuit Monitor digital inputs can be overlaid onto a Waveform capture, providing a comparison of the event with timing of the associated equipment status points (i.e., protective relay operations, etc.).
d. Waveform capture shall be initiated either from a Personal Computer Workstation (PCW) running the Power Monitoring and Control Systems software, or by the circuit monitor as a user defined response to an alarm condition.
e. Waveform capture manually triggered from the Power Monitoring and Control System software shall be captured at 512 samples/cycle for one cycle providing harmonic content up to the 255th harmonic for Ia, Ib, Ic, Ig, Va, Vb, Vc, Vg.
f. The Circuit Monitor shall transmit the waveform samples over the network to the personal computer workstation for display, archival, and analysis.
g. Each voltage and current of all the phases shall be sampled concurrently so that proper phase relationships are maintained, so that harmonic flow analysis can be performed, and so that the effect of a disturbance can be observed on all phase voltages and currents.
h. Harmonic analysis performed on the captured waveforms shall resolve harmonics up to the 255th using Power Monitoring and Control Software.
i. All waveforms must reflect actual circuit performance. Waveforms synthesized or composed over time shall not be acceptable.

20. Data logging may be accomplished either within the circuit monitor or at the PC Workstation, or both. Each circuit monitor shall be able to log data, alarms and events, and multiple waveforms. The monitors shall provide 8MB of on-board nonvolatile memory, which can be field upgraded without requiring disassembly or removal the Circuit Monitor. On board data logs shall be communicated to the PC Workstation upon demand or at scheduled intervals. Logged information to be stored in each Circuit Monitor includes:
    a. Up to 14 separate data logs shall be configurable by the user. Each log entry shall be date and time stamped. The type of data for the log shall be selected from a list of over 150 monitored values. Each log entry shall be user configurable to consist of from one to over 75 values of instantaneous data. It shall be possible to set up each log to record data at independent user defined intervals. In addition, it shall be possible for a user to define an event or new min/max condition that will trigger log file entries.
    b. Data logs can be configured by users to be Fill & Hold or Circular (FIFO).
    c. A Min/Max log file shall include the time, date, and value for the minimum and maximum of each of the instantaneous metered values since last reset. As well as a Min/Max/Avg. log that records the minimum/maximum/average readings for pre-defined quantities at a user-specified interval.
    d. An alarm and event log shall contain time, date, event information, and coincident information for each user defined alarm or event. This log shall have a capacity of up to 1,000 events.
    e. Waveform logs shall store captured waveforms as defined by the user. Waveform log entries shall be scheduled at user defined interval, externally triggered, or forced

in response to a user defined event. Waveform logs shall be either Fill & Hold or Circular (FIFO) as defined by the user.

f. The Power Monitoring and Control System software shall be available to enable the user to allocate onboard Circuit Monitor memory for each logging function.

21. Circuit Monitor Input/Output Options: Input/Output options/modules shall be field replaceable. Circuit Monitors shall provide preconfigured I/O options and also provide I/O options to be configured as applicable to each installation as shown on the project drawings:
    a. Option One - One solid state output suitable for KYZ pulse initiation; four solid state status inputs; three (10A) mechanical output relays
    b. Option Two – Four solid state status inputs; four analog inputs (4-20 mA)
    c. Option Three – Four inputs (32Vdc); 2 solid state outputs (60Vdc); 1 analog input (0-5Vdc); 1 analog output (4-20mA)
    d. Option Four - Eight solid state status inputs (120Vac)
    e. Option Five – Circuit Monitor shall provide configurable I/O options to include solid state input modules for 120Vac, 200Vac, and 32Vdc; solid state outputs modules for 120Vac, 240Vac, 60Vdc, 240Vdc; analog input modules for 0-5Vdc, 4-20mA; analog output module for 4-20mA.
22. Alarm events shall be a combination of pre-configured from the factory events and user definable events. Multiple levels of alarms can be configured for each metered parameter.
    a. The following classes of events shall be available as alarm events:
        1) Over/under current
        2) Over/under voltage
        3) Current imbalance
        4) Phase loss, current
        5) Phase loss, voltage
        6) Voltage imbalance
        7) Over kVA
        8) Over kW or kVAR into/out of load
        9) Over/under frequency
        10) Under power factor, true or displacement
        11) Over THD
        12) Over K-factor
        13) Over demand, current or power
        14) Reverse power
        15) Phase reversal
        16) Status Input change
        17) End of incremental energy interval
        18) End of demand interval
        19) Over/under analog inputs
        20) Current sag/swell
        21) Voltage sag/swell
    b. For each over/under metered value alarm, the user shall be able to define a pick-up, drop-out, and delay.
    c. There shall be ten alarm severity levels in order make it easier for the user to respond to the most important events first.
    d. Indication of an alarm condition shall be given on the local display as well as reported to the Power Monitoring and Control System software.
    e. The Circuit Monitor shall calculate key electrical parameters at 100ms intervals for the purpose of alarming and recording of data during an event. The recorded data shall be comprised of RMS readings for I, V, kW, kVAR, kVA, and True PF. 1-10 seconds of pre-event and up to 5 minutes of post event data can be recorded.
23. Output Relay Control
    a. Relay outputs shall operate either by user command sent over the communication link, or set to operate in response to user defined alarm event.
    b. Output relays shall close in either a momentary or latched mode as defined by the user.

c. Each output relay used in a momentary contact mode shall have an independent timer that can be set by the user.
d. It shall be possible for individual relay outputs to be controlled by multiple alarms in a wired “OR” configuration.

24. All Circuit Monitors noted on the project drawings shall include sag and swell detection capability. This capability is characterized by the following features:
    a. The Circuit Monitor shall continuously monitor for disturbances in the currents and incoming voltage. There shall be zero blind time; each cycle shall be individually monitored.
    b. Disturbance events less than 1/2 cycle in length shall be detected.
    c. The user shall be able to set a threshold and delay which shall be used by the circuit monitor to determine if an event has occurred. The threshold shall be user defined as either a fixed setpoint or relative setpoint. When using the relative setpoint, the Circuit Monitor will set the nominal current or voltage equal to its present average value. The Circuit Monitor will automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
    d. Upon detecting a disturbance, the Circuit Monitor shall be capable of:
        1) Logging a waveform of the event all phase currents and voltages and/or a high-speed 100ms RMS event recording.
        2) Operating any output relay on an optional I/O module.
        3) Recording the disturbance into an event log with a date and time stamp to the millisecond.
        4) Causing an operator alarm at the PCW workstation.
    e. All data and waveform logs shall be communicated over the local area network or through the front panel communications port so that the user may view and analyze the data using the PMS software and workstation.
25. Advanced harmonic information shall be available via the Circuit Monitor. This shall include the calculation of the harmonic magnitudes and angles for each phase voltage and current through the 255th harmonic.
    a. This information shall be available for all three phases, current and voltage, plus the neutral current. To ensure maximum accuracy for analysis, the current and voltage information for all phases shall be obtained simultaneously from the same cycle.
    b. The Circuit Monitor shall have a minimum of 8 MB of on board memory, which can be utilized to log harmonic magnitudes and angles, and other Circuit Monitor data.
    c. The harmonic magnitude shall be reported as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

C. Circuit Monitors (Square D CM 3350)

1. Same features as CM4000 except no voltage transient detection or extended I/O.

D. Power Meter with Waveform Capture (Square D PM850 (basis of design) / Cutler Hammer IQ6600)

1. Electronic power meters shall provide true rms metered values. Information provided by each power meter shall include frequency, current, demand current, voltage, real power, reactive power, apparent power, demand power, predicted demand power, power factor, accumulated energy, accumulated reactive energy and total harmonic distortion (THD) of each current and voltage and date/time stamping.
2. PM 850 power meter shall have a 4-line LCD display, RS-485 communications capability and transmit all data back to the PMS. Meter shall have a minimum of 800KB memory for alarm/event and min/max logging, KYZ output, 0.5 percent accuracy and waveform capture capability.
3. Meter shall be connected to the system via use of split core CT’s. to allow installation to existing feeders.

E. Electrical Load Sub-Metering (Square D MCM w/Display PMCMD)

1. Electronic local sub-metering shall provide true rms metered values. Information provided by each sub-meter shall include frequency, current, voltage, real power, reactive power, demand power, power factor and real energy.
2. Meter shall have RS-485 communications capability and have a 1 percent accuracy.
3. Meter shall be connected to the system via use of split core CT's to allow installation to existing feeders.

2.8 Distributed I/O

A. The PMS system shall accommodate a Distributed I/O and Programmable Control system architecture. There shall be two levels of functionality – Distributed Input modules and Distributed Programmable Logic Controller (PLC) processors.

B. Distributed I/O devices shall be manufactured by the PMS vendor.

C. Distributed I/O modules must comply with the following specifications:

1. Equipment: IEC 1131-2
2. Safety class: Class 1, IEC 536
3. Safety type: IEC 529, IP20
4. Shock: IEC 68.2-6EC
5. Vibration: IEC 68.2-27EA
6. Dielectric: IEC 664
7. Transient Bursts: IEC61000-4-4

D. Devices shall have a removable "top hat" design to allow flexibility in hardware configuration. Top hats should be available to allow simple Input modules without PLC programming, or processor Top hats to provide full PLC programming capability.

1. Top hats should be available with a variety of protocols, including: PowerLogic protocol (SyMax), Modbus serial, and Modbus-TCP for Ethernet.
2. Option modules shall be available to provide additional communication ports (RS-232 or RS-485), as well as Time-of-Day Clock/Calendar functionality.

E. Distributed Input modules

1. Compatible with the PMS system for Digital Status Inputs, without any PLC programming required.
2. Status from Digital inputs should be able to be displayed in data screens, logged in the time/date stamped system Event log, and able to generate an Alarm.
3. Analog inputs must be able to be scaled into Engineering units, displayed as instantaneous values, logged in the historical database, provide alarming based upon setpoints, and utilized in the HTML based reports (cost allocation, historical trending, and historical data tables).

F. Indoor installations – Distributed I/O modules shall be mounted in Indoor NEMA wall mount enclosures or on metal back plates if being installed inside existing Switchgear compartments. All components and accessories must be mounted and pre-wired with fusing. All terminals shall be brought to a customer connection terminal strip. PMS vendor to provide a CAD drawing showing enclosure layout, wiring, and customer field connections.

2.9 Remote Equipment Monitoring

A. A variety of other equipment shall be integrated into the PMS to allow on-screen selection of the device to view monitoring data points and alarms. Refer to the drawings and Monitoring Summary Schedule.

B. Miscellaneous Monitoring

1. Integrate additional points such as transformer temperature, TVSS alarm, waterflow alarm etc. into the PMS Graphical, Data and Alarm Displays.

C. Circuit Breaker Trip Units

1. Integrate all circuit breaker trip units into the Power Monitoring System. Refer to specification section 26 23 13.

PART 3 - EXECUTION

3.1 Installation

A. PMS components, including Circuit Monitors, Power Meters, Power Servers and I/O modules, included within the power equipment lineups shall be factory installed, wired and tested at the factory and again at the job site.

B. All control power, CT, PT and data communications wire shall be wired and harnessed within the equipment enclosure.

C. Where external circuit connections are required, terminal blocks shall be provided and CAD drawings must clearly identify the interconnection requirements including wire type to be used.

D. Interconnection wiring requirements shall be clearly identified on the PMS system drawings.

E. All equipment shall be securely mounted in enclosures or special-mounting devices made for the purpose and be clearly, permanently marked.

F. All equipment shall be properly grounded to meet NEC code requirements and to prevent electromagnetic or electrostatic interference.

G. All penetrations in smoke or firewalls shall be sealed with fire stop rated for this purpose.

3.2 Wiring Installation

A. Wiring shall be furnished and installed in accordance with manufacturer’s recommendations, industry standards and in compliance with all Local, City, State and National Codes. All wiring, not inside equipment enclosures, shall be installed in conduit.

B. All wiring entering/leaving switchgear or cabinets shall be properly routed and secured. Wires and cables used in assembling switchgear or cabinets shall be formed into harnesses which are tied and supported for proper strain relief. Harnessed cables shall be combed straight. Each cable that breaks out from the harness for termination shall be provided with an ample service loop and shall not violate the minimum bend radius of the cable.

C. Provide all required control cabling between equipment as required by the manufacturer.

D. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.3 Grounding

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA and the vendor.

3.4 Programming

A. It is the vendor's responsibility to program the system in this section according to the Owner's wishes. The vendor shall meet with the Owner and Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

3.5 Identification/Labeling

A. Contractor shall identify and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered. All control and signal cables shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

B. The Contractor shall clearly and logically label all terminal blocks, cables and equipment and ensure that labeling coordinates with the as-built documentation.

3.6 Tests

A. Upon completion of installation and satisfactory testing of system by Contractor in presence of the equipment supplier, the Contractor shall test the system in the presence of the Owner and the Engineer.

B. System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; Submit report indicating result to the Engineer.

3.7 System Start-up and Training Requirements

A. The equipment supplier shall provide system integration, set-up and start-up assistance to the Installing Contractor. The proposal shall include complete technical onsite assistance for these activities as required for this system's size and complexity. After completion of the installation, the supplier shall commission the system and request an initial acceptance test by the Owner and Engineer. A final acceptance test shall then be scheduled after correcting any system deficiencies or functionality issues that are determined in the initial test. Provide 2 days of training, by a system certified trainer, at the project site as coordinated with the Owner. The training shall include the following elements:

1. Start-up shall include a complete working demonstration of the PMS.
2. Demonstrate adjustment, operation and maintenance of the system including each component and control.
3. A final technical training session, which shall include hands-on training, accompanied by full system documentation and system as-built drawings.
4. Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMS after completion of the training period.
5. Provide a manufacturer's "Certificate of Completion" that is signed, dated and documented for each trainee.
6. The power monitoring vendor shall offer regularly scheduled factory training to the Owner on all aspects of power monitoring and control, including:

a. Comprehensive software and hardware setup, configuration, and operation
b. Advanced monitoring and data reporting
c. Advanced power quality and disturbance monitoring.

7. The power monitoring manufacturer shall provide a dedicated technical support center for the Owner.

B. This training period shall be scheduled with the Owner after the successful completion of the system. Training on a demonstration system will not be accepted.

C. Manufacturer shall have total single point of contact responsibility for all aspects of PMS implementation, including equipment supply, integration, customization, start-up, and on-going systems support.

D. Manufacturer shall employ a service technician within 100 miles of project site that is specially trained and certified to modify and repair the PMS system.

E. Manufacturer shall employ a product specialist within 100 miles of project site who specializes in PMS and power system integration.

F. Provide off site Priority Support Training as defined in para. 2.6.D within this proposal.

G. Supplier shall provide a follow-up site inspection / training refresher to the Owner 60 days after final acceptance to verify system is operating correctly within programmed parameters and to review operational and training with Owner personnel.

3.8 As-Built Documentation

A. The Contractor shall furnish the Owner two (2) complete bound as-built manuals in an 8.50 inches x 11 inches format. Drawings shall be a minimum of 11 inches x 17 inches engineering format. These manuals shall be assembled in a loose leaf binder and shall contain:

1. System Operating Instructions
2. System Single Line Diagrams
3. System Detailed Wiring Diagrams
4. Component Technical Operating Manuals
5. Component Service Manuals

3.9 Warranty

A. Provide a two (2) year full warranty of the system, including equipment, wiring and software against defects in material and workmanship from the date of system completion and final acceptance. If any defects are found within the warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period. Provide estimated cost of this service contract within the proposal.

C. The equipment supplier shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (4) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system component operation, or the loss of the main server.

D. If equipment cannot be repaired within 24 hours of service visit, the equipment supplier shall provide “loaner” equipment to the Owner at no charge.

E. Proper identification is required and must be visible while on-site for warranty / service calls. Provide notification of completion to the Owner prior to departing the site.

3.10 Certification

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that they have tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification.

PART 4 - UNIT PRICES

4.1 Unit Price Schedule

A. The vendor shall provide a unit price for the following items listed in this specification:
   1. CM4000 Circuit Monitor
   2. CM3350 Circuit Monitor
   3. PM850 Power Meter
   4. Remote I/O Distribution Block (16 point discrete input)
   5. Remote Touchscreen Display

B. These unit prices will be used as a basis to add or deduct items from the project as determined by the Owner or Engineer.

END OF SECTION

26 09 16 ELECTRICAL POWER METERING SYSTEM

PART 1 - GENERAL

1.1 Scope

A. This section defines the low voltage metering solution for use in the AC electrical equipment as outlined in the one-line and/or riser drawings. These solutions will provide a low voltage metering system integrated into the electrical equipment. The multi-customer energy sub-meter solution shall offer an efficient system for commercial sub-metering. The metering system shall provide the ability to report the energy information remotely using a web based software platform. The system shall be expandable to accept non-electrical meter input.

1.2 Related Documents

A. Drawings and general provisions of the Contract, including General and supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Section 26 23 00 – Low Voltage Switchgear
2. Section 26 24 13 – Distribution (Below 600 volts) Switchboard
3. Section 26 24 16 – Panelboards
4. Section 26 24 19 – Motor Control Centers
5. Section 26 – Electrical Installation

1.3 Submittals

A. Submit shop drawings and product data for approval and documentation in the quantities listed according to the Conditions of the Contract.

1. System diagram showing location of computers, repeaters, gateways and assemblies / devices to be connected to system. A general layout of wiring with specifics for building layout.
2. Typical screen displays for user system monitoring reports.
3. Hardware and software description. List for all communicating devices to be connected to network.

B. Final Documents: Record documentation to include but not limited to: as-built wiring diagrams, meter/breaker/load schedule, factory test results and certificate(s), system commission report, manufacturers contact information, operation and installation manuals.

1.4 Related Standards

A. Meet the following recognized standards for applications:

1. Accuracy
   a. ANSI C12.1
   b. ANSI C12.20/0.2
2. Safety/Construction
   a. CSA C22.2 No. 1010-1 Safety Requirements for Electrical Equipment and Measurement
   b. UL916 Energy Management Equipment
   c. UL61010-1 (IEC 61010-1) Test and Measurement Equipment
3. Electro Magnetic Compatibility
   a. FCC Part 15 subpart B, Class A Digital Device, Radiated Emissions
   b. IEC 61000-4-2 Electrostatic Discharge (B)

c. IEC 61000-4-3 Related Immunity (A)
d. IEC 61000-4-4 Electric Fast Transient (B)
e. IEC 61000-4-5 Surge Immunity (B)
f. IEC 61000-4-6 Conducted Immunity

1.5 Quality Assurance

A. Manufacturer Qualifications:

1. Manufacturer of this equipment shall have a minimum of 5-years experience producing electronic submetering system equipment.
2. Comply with requirements of latest revisions of applicable industry standards.

1.6 Delivery, Storage and Handling

A. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. If the meters are installed in equipment, store the equipment so condensation will not form on or in it. If necessary, apply temporary heat where required to obtain suitable service conditions.

PART 2 - PRODUCTS

2.1 Manufacturers

A. The low voltage power meter shall be SEM3 metering solutions by Siemens or preapproved equal. Approved manufacturers are as follows:

1. Siemens (ACCESS)
2. Square D Powerlogic System
3. Eaton

2.2 Hardware Overview

A. The meters and auxiliary equipment must meet revenue approval. Metering equipment to be compatible with monitoring software. Communication to power metering devices shall be Modbus using Modbus TCP via an Ethernet network at 10/100 M baud using UTP or fiber connections.

B. Switchgear and Switchboard Power Meters

1. Integrate the switchgear and switchboard power meters into the power monitoring system. Refer to specification sections 26 23 00 and 26 24 13.

C. Circuit Breaker Trip Units

1. Integrate all circuit breaker trip units into the power monitoring system. Refer to specification section 26 23 13.

D. Panelboards

1. Integrate the panelboard controller and individual meter modules for branch circuit monitoring. Refer to specification sections 26 24 13.

E. Miscellaneous Monitoring

1. Integrate additional points such as TVSS alarm, waterflow alarm, etc. into the PMS graphical data and alarm displays. Provide interface transducer.

F. The meters and controller shall be powered from its own voltage inputs.

G. Service Types

1. Single Phase Three Wire
2. Three-Phase Four Wire

H. Metering Data

1. Energy: The Meters shall provide true RMS, fully bi-directional and either r-quadrant revenue accurate or revenue certified energy metering for the following parameters.
   a. kWh delivered and received.
   b. kWh, kvarh, kVAh net (delivered – received)
   c. kWh, kvarh, kVAh total (delivered + received)
   d. kvarh, kVAh delivered and received
   e. Integration of any instantaneous measurement
2. Energy registers shall be logged automatically on a programmed schedule by a supervisory system.
3. Instantaneous: The meters shall provide high accuracy, 1 second, ½ cycle measurements, including true RMS per phase and total for the following parameters.
   a. Voltage and current
   b. Apparent power (kVA)
   c. Voltage and current unbalance
   d. Phase reversal
4. Min / Max Recording: The meters shall record each new minimum and new maximum value with date and time-stamp for the following parameters:
   a. Voltage and current min/max
   b. kW, kvar, and kVA min/max
   c. Power factor
   d. Frequency
   e. Voltage unbalance

PART 3 - EXECUTION

3.1 Installation

A. The Contractor shall furnish, install and terminate all communication conductors and associated conduits external to any factory supplied equipment.

B. All communications conductor wiring and routing shall be per the manufacturer's recommendations and as shown on the contract drawings.

C. Additional connections to metering systems, where applicable, shall be done in the field by the installing contractor.

D. Where external circuit connection are required terminal blocks shall be provided and CAD drawings shall clearly identify the interconnection requirements including type of wire to be used.

3.2 Adjusting and Cleaning

A. The meters shall be adjusted so that accurate readings appear on the front of the meter and that the readings are within the meters accuracy range.

B. Clean exposed surfaces using manufacturer recommended materials and methods.

3.3 Programming

A. It is the vendor's responsibility to program the system according to the Owner's wishes. The vendor shall meet the Owner and Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

3.4 Testing

A. Perform factory and installation tests in accordance with applicable NEC, NEMA, UL and ANSI requirements.

3.5 Warranty

A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one-year from date of initial operation.

3.6 Startup Services

A. Engage a factory-authorized service representative to perform startup service.

B. Provide a qualified tradesman to assist in the commissioning of system.

C. Obtain and submit as part of final documents a field commissioning report.

D. Verify that the mete(s) are installed and connected according to the Contract Documents.

E. Complete installation and startup checks according to manufacturer's written instructions.

3.7 Training

A. Provide hands-on training for 2 users in set-up, operation of the metering software. Minimum to include how to modify, add and delete metering areas.

B. Provide 2 training classes on how to access; and read reports. Provide metering dashboard recorded video of one session for future user training.

3.8 Support

A. The electrical equipment manufacturer shall provide a 1–800 number for telephone support.

B. The vendor shall provide training at a dedicated training facility, complete with software, devices and demonstrations or offer remote training services if required. With a software service agreement provide cost for 2nd and 3rd year remote training.

C. The vendor shall also provide on-line support for technical information and literature.

END OF SECTION

26 09 23 LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 Lighting control devices are identified on the drawings per legend symbols or as specifically noted. Catalog numbers from acceptable manufacturers for the common wiring devices shall be as listed herein. Catalog numbers are not listed for all devices. Other devices, such as key switches, clock hanger outlets, etc. shall be furnished by one of the manufacturers listed and shall be equal in quality to the device series listed.

1.2 When shop drawings are required for wiring devices the submittal shall be comprehensive for all wiring device configurations listed in the legend and for devices specifically noted on the drawings, including wall box dimmers, occupancy sensors and load control relays.

PART 2 - PRODUCTS

2.1 Toggle type AC switches shall be listed by Underwriters Laboratories, Inc. Switches shall be 20 ampere, 120/277 volt AC and ivory (select color) in color unless noted otherwise.

Acceptable Manufacturer	General Purpose	Red Pilot Lighted	Illuminated Handle	Momentary
Eaton	AH1221 series	AH1221 PL series	AH1221 LT series	1995 series
Bryant	4901 series	4901 PL series	4901 GL series	4921 series
Hubbell	HBL1221 series	HBL1221 PL series	HBL1221 IL series	HBL1557 series
Leviton	1221-S series	1221 PL series	1221 LH series	1257 series
P&S	PS20AC2 series	PS20AC2 RPL series	20AC1 SL series	1251 series

2.2 Ceiling/Wall Mount Occupancy Sensor

A. Sensor shall be dual technology to detect human presence in controlled area by ultrasound and passive infrared. Dual sensing with both technologies must occur to activate lighting system. Sensor to be fully adaptive with self-adjusting and self-calibration.

B. Sensor shall have signal processing to respond to only those signals caused by human motion. Sensor to operate instantly for room motion and time off delay adjustable for 5 – 30 minutes. Sensor to be equipped with a walk-thru mode.

C. Sensor area coverage to be minimum of 1000 SF for one sensor. Provide multiple sensors where needed for space coverage.

D. Sensor shall have provisions for manual-off function for lighting circuit from remote momentary switch (reset when not occupied) or maintained (off override).

E. Integral photosensor for delaying turn-on of fixtures when sufficient light available in the space. Provide in ceiling mounted sensor where noted on drawings.

F. Power pack for remote mounting to match occupancy sensor.

G. Verify color with Architect.

H. All components to have 5-year warranty.

I. Manufactured by Watt-Stopper, Greengate (Cooper Controls), Hubbell Control Solutions, Leviton, Sensor Switch or Lutron.

2.3 Wall Switch Occupancy Sensor (Small Offices and similar room w/single entry door)

A. Switching w/manual and automatic control. Sensor shall use PIR sensing and shall have photocell/daylight override, vandal resistant lens. Sensor to be fully adaptive with self-adjusting and self-calibration.

B. Switches to provide two level and incorporate two dedicated relays in addition to the manual switches.

C. Verify color with Architect.

D. All components to have 5-year warranty.

E. Manufactured by Watt Stopper, Greengate (Cooper Controls), Hubbell Control Solutions, Leviton, Sensor Switch or Lutron.

2.4 Daylight Harvesting Systems

A. Single Zone Continuous Dimming Daylighting Controller

1. Ceiling mounted 0-10VDC closed loop photo sensor, greater than 1 inch accuracy to measure total light at task plane. Full range dimming, spectral response similar to human eye, set points adjustable from 20-60FC, 50 ballast control or compatible LED drives, five-year warranty.
2. Occupant adjustment handheld remote control for raise/lower and auto operation and nighttime and daytime setpoint functions.
3. Wattstopper #LMLS-400 or equal by Hubbell Control Solutions or Sensor Switch.

B. Single Zone Switching Daylighting Controller

1. Ceiling mounted 0-10VDC closed loop photo sensor, controller and LCD Display. Set points adjustable from 1-1400FC, five year warranty.
2. 100 degree peak sensitivity cone of vision, optional LV override switch input, test mode, 4 user selectable set points, and LED status indicator.
3. Wattstopper #LMLS-400 or equal by Hubbell Control Solutions or Sensor Switch.

C. Multi-Zone Continuous Dimming Daylighting Controller

1. Ceiling mounted 0-10VDC open loop photo sensor to detect incoming natural daylight, 3-300FC, 30-3000FC and 60-6000FC selectable ranges, five year warranty; Wattstopper #LMLS-600 or equal by Hubbell Control Solutions or Sensor Switch.
2. Three zone low voltage daylight harvesting dimming controller, 0-10VDC, 7 adjustable parameters for each zone (set point, min output, max output, ramp rate, fade rate, cutoff time delay and load shed limit). Menu driven programming, internal calculations for dimming, wall switch inputs, and DIN rail mounting; Wattstopper #LCD-203 with #BT-203 power pack or equal by Hubbell Control Solutions or Sensor Switch.
3. Low voltage wall switch with “AUTO”, “ON/OFF”, “RAISE” AND “LOWER” buttons and single gang faceplate; Wattstopper #LS5C or equal by Hubbell Control Solutions or Sensor Switch.
4. Mount controller and power pack in a NEMA 1 enclosure with DIN rail above accessible ceiling near line voltage wall switches (or near door); Wattstopper #LS-E8 or equal by Hubbell Control Solutions or Sensor Switch.

D. Submit manufacturer designed 1/8 inch scale floor plans with cut sheets for shop drawing review showing model numbers, coverage pattern of photo sensors, zones and control, mounting instructions, etc. Submittals missing this information will be rejected.

2.5 Electronic Low Voltage (0 – 10V) Dimmer

A. General Requirements

1. Utilize air gap off, activated when user selects "off" to disconnect the load from line supply.
2. Operates at the rated capacity across the full ambient temperature range including modified capacities for ganged configurations which require removal of fins.
3. Provide radio frequency interference suppression.
4. Surge Tolerance: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
5. Dimmers: Provide full range, continuously variable control of light intensity.
6. Dimmers for Electronic Low Voltage (ELV) Transformers:
   a. Provide circuitry designed to control the input of electronic (solid-state) low voltage (ELV) transformers. Do not use dimmers that utilize standard phase control.
   b. Provide resettable overload protection that provides automatic shut-off when dimmer capacity is exceeded. Do not use protection methods that are non-resettable or require device to be removed from outlet box.
   c. Designed to withstand a short, per UL 1472, between load hot and either neutral or ground without damage to dimmer.
7. Fluorescent Dimmers:
   a. Provides direct control of fluorescent dimming ballasts up to the ballast manufacturer's specified rating.

B. Preset Smart Wall Dimmers and Switches:

1. Dimmer Control: Multi-function tap switch with raised rocker for dimmer adjustment.
   a. Rocker raises/lowers light level, with new level becoming the current preset level.
   b. Switch single tap raises lights to preset level or fades lights to off.
   c. Switch double tap raises light to full on level.
   d. Switch tap and hold slowly fades lights to off over an extended period.
   e. LEDs adjacent to tap switch indicate light level when dimmer is on, and function as locator light when dimmer is off.
   f. Preset Smart Dimmer: 3-wire fluorescent ballast/LED driver (6 A, 120 V); multi-location capability using companion dimmers (up to nine companion dimmers may be connected); minimum load requirement.
   g. Companion Dimmer: Provides multi-location capability for compatible dimmers.

C. Preset Smart Wall Dimmers and Switches with Wireless Communication Inputs:

1. Communicates via radio frequency with up to nine compatible occupancy/vacancy sensors and/or wireless control stations, and one daylight sensor.
2. Dimmer Control: Multi-function tap switch with small, raised rocker for dimmer adjustment.
   a. Rocker raises/lowers light level, with new level becoming the current preset level.
   b. Switch single tap raises lights to preset level or fades lights to off.
   c. Switch double tap raises light to full on level.
   d. Switch tap and hold slowly fades lights to off over period of 10 seconds.
   e. LEDs adjacent to tap switch indicate light level when dimmer is on, and function as locator light when dimmer is off.

D. Dimmer shall be rated for the wattage it is supplying. Contractor shall coordinate lighting load on each respective dimmer and provide properly rated dimmer accordingly (600w to 1000w).

E. Contractor is responsible to coordinate the dimmer with each lighting manufacturer and verify that dimmer is compatible and capable of controlling lighting loads/fixtures from fixture manufacturer being supplied on the job.

F. Verify color of dimmer with architect prior to ordering.

G. Dimmer shall control loads down to 10%.

H. 0-10V electronic digital dimmer shall be Lutron Skylark Contour, Leviton IllumaTech, Hunt Simplicity, Cooper Slide, Watt Stopper Architectural or approved equal.

2.6 Provide a device plate to suit each particular application. Cover all empty outlet boxes with a blank plate. Coverplates shall be manufactured by Pass and Seymour, Hubbell, Cooper, Bryant, Leviton or Mulberry; Taymac is an acceptable manufacturer for weatherproof non-metallic coverplates Multi-Mac Series, “While-In-Use” type, 3.5 inches depth, opaque grey, locking tab, marked “EXTRA Duty”. Provide jumbo sized plates for outlets installed in masonry walls.

2.7 In finished spaces, wall plates shall be nominal .032 inch thick, made of 302 high nickel stainless steel with brushed satin finish and beveled edges. Screws shall be metal with countersunk heads and finished to match plates. Sectional plates will not be permitted.

2.8 In finished spaces, wall plates shall be unbreakable Lexan or nylon, non-combustible, minimum 0.100 inch thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

2.9 In finished spaces, wall plates shall be thermoset plastic (phenolic, urea), non-combustible, mar proof, minimum 0.100 inch thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

2.10 Installations consisting of three or more wall switches or wall box dimmers mounted together with either separate coverplates or a common coverplate shall have each coverplate engraved so as to identify the circuits or fixtures being controlled by each switch or dimmer. Refer to the drawings for special instructions.

PART 3 - EXECUTION

3.1 Locate devices as shown on the drawings, coordinate exact location with other trades, to avoid interference. Check for potential interference from door swings, cabinets, HVAC equipment and other wall mounted devices.

3.2 Clean debris from device boxes prior to installation of devices. Adjust devices and coverplates to be flush and level.

3.3 Control Cabling Installation

A. Lighting control low voltage wiring shall be furnished and installed in accordance with manufacturer’s recommendations in compliance with all Local, State and National codes. This Contractor shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide firestop material and seal all cable penetrations as required.

C. All wiring shall be organized and run parallel or perpendicular to building lines above ceilings. Provide all required cable management systems such as J-hooks to support wiring to meet building codes and manufacturer’s recommendations.

D. Cables shall not be laid upon ceilings, structure or equipment or supported in a manner that would violate any codes or standards.

E. All cabling installed in accessible ceiling spaces shall be UL plenum rated.

F. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.4 Identification/Labeling

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

3.5 Occupancy Sensor Installation

A. Verify location of occupancy sensor(s) with selected manufacturer prior to rough-in to minimize false activation of the device. Locate sensor and adjust activation field to avoid nuisance activation by movement outside of the controlled space. Sensors shall sense any human motion in the space and allow turn on with entrance into the space.

B. Provide all material and labor for a complete and operational system including power and slave packs, auxiliary relay modules and backboxes. Verify application voltage rating and provide proper rated devices.

C. Low voltage wiring can be open wired above accessible ceilings, utilize plenum rated cabling. Installation in exposed or inaccessible locations shall be installed in conduit.

D. Coordinate time delay off setting of each occupancy sensor with the Owner. Maximum time delay off shall be 30 minutes. Minimum off delay is 10 minutes for intermittent use spaces.

E. Maintain 6 feet (minimum) to 8 ft. distance from an HVAC air outlet.

3.6 Daylight Harvesting Installation and Commissioning

A. Prior to installation, during installation and after installation manufacturer shall coordinate proper mounting locations, aiming, set up, calibration, etc. of every device. At completion of project, manufacturer shall submit proof every device is calibrated and commissioned and in good working order.

B. Minimum of 2 hours of Owner training shall be provided by manufacturer's representative on use of remote controls, low voltage wall switch, system components (accessible and concealed), maintenance and how to maximize energy savings. Submit outline and Owner signature sheet that this has been completed at completion of project.

C. Provide 2 spare photo sensors of each type used on project, 2 spare remotes and 2 spare multi-channel dimming controllers/power packs used on the project. Submit proof of spares turnover to Owner with O&M Manuals.

3.7 Functional Testing – Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer’s installation instructions. When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

A. Occupant Sensors

1. Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
2. For projects with up to seven (7) occupancy sensors, all occupancy sensors shall be tested.

3. For projects with more than seven (7) occupancy sensors, testing shall be done for each unique combination of sensor type and space geometry.
    a. For each sensor to be tested, verify the following:
        1) Status indicator (as applicable) operates correctly
        2) Controlled lights tum off or down to the permitted level within the required time
        3) For auto-on occupant sensors, the lights tum on to the permitted level when someone enters the space
        4) For manual-on sensors, the lights turn on only when manually activated
        5) The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation

B. Automatic Time Switches

1. Confirm that the automatic time-switch control is programmed with appropriate weekday, weekend, and holiday (as applicable) schedules.
2. Document for the owner automatic time-switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
3. Verify that correct time and date are properly set in the time switch.
4. Verify that any battery backup (as applicable) is installed and energized.
5. Verify that the override time limit is set to no more than two (2) hours.
6. Simulate occupied condition. Verify and document the following:
    a. All lights can be turned on and off by their respective area control switch.
    b. The switch only operates lighting in the enclosed space in which the switch is located.
7. Simulate unoccupied condition. Verify and document the following:
    a. All nonexempt lighting turns off
    b. Manual override switch allows only the lights in the enclosed space where the override switch is located to tum on or remain on until the next scheduled shut off occurs

C. Daylight Controls

1. All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate setpoints and threshold light levels.
2. Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
3. The location where calibration adjustments are made is readily accessible only to authorized personnel.

D. Testing shall be performed by equipment supplier. Provide report certifying operation and performance level to Engineer.

3.8 Training Requirements

A. Provide all training and utilize specified manuals and record documentation. Training shall be provided to all Owner designated staff at the project site.

B. Demonstrate adjustment, operation and maintenance of the system including each component and control.

END OF SECTION

26 09 43.16 NETWORK LIGHTING CONTROLS (BAS INTERFACE)

PART 1 - GENERAL

1.1 System Description

A. The Addressable Networked Light Management System shall be a system of Luminaire Control Modules, Sensor Interface Modules, Network wall switches, occupancy sensors (wireless and/or wired) and light level sensors (wireless and/or wired). These field devices shall connect to the Energy Control Units and System Support Unit and be controllable and monitored through the Building Automation System operator interface and the local control software.

B. The Addressable Networked Light Management System shall integrate with the Building Automation System such that the operator can view lighting state and occupancy level for each controlled zone of lighting.

1.2 Scope of Work

A. The Division 26 Contractor shall furnish all labor to install the Addressable Networked Light Management System furnished by the Division 25 Contractor. The Division 26 Contractor shall receive the Addressable Networked Light Management System components from the Division 25 Contractor and store them in a secure and dry location. The Division 26 Contractor shall provide all of the required materials (including but not limited to; wire, conduit, fasteners, junction boxes, switch boxes, raceways, and face plates) and make all of the line and low voltage wiring terminations to ensure the Unified Lighting Control System functions properly and in accordance with the specifications and drawings. The Division 26 Contractor shall provide installation as-built drawings to the Division 25 Contractor.

B. The Division 25 Contractor shall furnish all components of the Addressable Networked Light Management System as indicated per the specifications and drawings. These components shall consist of energy control Units, System Support Unit, Luminaire Control Modules, Sensor Interface Modules, network wall switches, occupancy sensors (wireless and/or wired) and light level sensors (wireless and/or wired). The Division 25 Contractor shall provide the Division 26 Contractor all necessary documents, including approved submittal package, riser diagrams and termination schematics required to provide a complete and correct installation.

1.3 Related Sections

A. The following sections constitute related work:

1. Section 23 09 23 – Direct Digital Control System for HVAC
2. Section 25 56 00 – Integrated Automation Control of Electrical Systems
3. Section 26 05 00 – Common Work Results for Electrical
4. Section 26 06 00 – Schedules for Electrical

1.4 Contractor Provided Submittals

A. Provide complete and accurate as-built drawings to Division 25 Contractor prior to the Addressable Networked Light Management System Check-out and Testing.

B. As-built drawings shall document all line voltage and low voltage wiring information necessary to program and complete the Unified Lighting Control System, including but not limited to”
1. Low voltage network wiring information;
2. Low voltage wiring for low voltage field devices;
3. Line voltage wiring for Energy Control Units and System Support Unit.

1.5 Warranty

A. Contractor shall provide twelve (12) month warranty on the installation of the Addressable Networked Light Management System. Warranty shall include all labor and materials furnished (including but not limited to; pipe, wire conduit, fasteners, junction boxes, switch boxes raceways, and face plates) and all line and low voltage wiring terminations. If within twelve (12) months from the date of acceptance of the Addressable Networked Light Management System, upon written notice from the Owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the Division 26 Contractor.

PART 2 - PRODUCTS

2.1 Greenbus Wiring

A. Contractor shall use Division 25 Contractor furnished 18 gauge two wire low voltage cable and cable connectors.

B. Contractor shall field test each cable run with Division 25 Contractor furnished tester to verify working low voltage network.

2.2 Energy Control Units

A. Install Energy Control Units as detailed on drawings.

B. Provide with non-emergency 20A 120V receptacle power (200W max load)

2.3 System Support Unit

A. Install Energy Control Unit as detailed on drawings.

B. Provide with emergency (if available) 20A 120V receptacle power (300W max load).

2.4 Network Switch

A. Install Energy Control Unit as detailed on drawings.

B. Provide with emergency (if available) 20A 120V receptacle power (300W max load).

2.5 Luminaire Control Modules

A. Area Lighting Controller (ALC)

1. Install ALC as detailed on drawings. Utilize line voltage circuit as indicated on plans.
2. ALC serving battery backup emergency luminaire(s) must have constant hot line voltage wire bypassing ALC. Label fixture and ALC service fixture with label designating emergency luminaire and circuit being utilized.
3. Install ALC 0-10V wiring to luminaires as required by plans.
4. Locate ALC in easily accessible location above ceiling and label device with circuit identifier and lighting control being served.

B. Luminaire Control Module (LCM)

1. Install LCM as detailed on drawings. Utilize line voltage circuit as indicated on plans.
2. LCM serving battery backup emergency luminaire(s) must have constant hot line voltage wire bypassing LCM. Label fixture and LCM serving fixture with label designating emergency luminaire and circuit being utilized.

3. Install LCM 0-10V wiring to luminaires as required by plans.
4. Locate LCM externally on luminaire knockout or in easily accessible location above ceiling and label device with circuit identifier and lighting zone being served.

C. Dual Relay Luminaire Control Module (DRLCM)

1. Install DRLCM as detailed on drawings. Utilize line voltage circuit as indicated on plans.
2. DRLCM serving battery backup emergency luminaire(s) must have constant hot line voltage wire bypassing DRLCM. Label fixture and DRLCM serving fixture with label designating emergency luminaire and circuit being utilized.
3. Locate DRLCM in easily accessible location above ceiling and label device with circuit identifier and lighting zone being served.

D. Accessory Control Module (ACM)

1. Install ACM as detailed on drawings. Utilize line voltage circuit as indicated on plans.
2. ACM serving battery backup emergency luminaire(s) must have constant hot line voltage wire bypassing ACM. Label fixture and ACM serving fixture with label designating emergency luminaire and circuit being utilized.
3. If required, install accessory dimming module provided by Division 25 Contractor for control of non 0-10V dimming luminaires. Install accessory dimming module as detailed on drawings.

2.6 Relay Panels

A. Install relay panel as detailed on drawings.

B. Provide as-built drawings showing all relay terminations in relation to submittal drawings along with circuit serving those relays.

2.7 Wall Stations

A. Rocker Wall Switch Station

1. Install wall switch as shown on drawings.
2. Switches may be multi-ganged with other wall stations in same junction box.

B. Zone Control Wall Station

1. Install zone control wall station as detailed on drawings.
2. Wall station may be multi-ganged with other wall stations in same junction box.

C. Scene Control Wall Station

1. Install scene control wall station as detailed on drawings.
2. Wall station may be multi-ganged with other wall stations in same junction box.

2.8 Sensor Interface Modules

A. Install Sensor Interface Module (SIM) as detailed on drawings.

B. Locate SIM in accessible junction box serving local sensor or in another easily accessible location with other Addressable Lighting Control Network System components.

2.9 Low Voltage Occupancy Sensors

A. Install low voltage (24 VDC) occupancy sensors as detailed on drawings.

1. Line voltage occupancy sensors are not part of the Addressable Lighting Control Network System.

B. Low voltage occupancy sensors shall have a minimum times value of 30 seconds or less. Set all low voltage occupancy sensor timers to the minimum setting and document settings in the as built documents provided to the Division 25 Contractor.

2.10 Wireless Gateways

A. Install Wireless Gateways as shown on the drawings.

B. Locate Wireless Gateway above ceiling mounted to a junction box with antenna pointed down.

2.11 Wireless Switch

A. Install Wireless Switch as detailed on drawings.

B. Verify wireless connection to wireless gateway before permanent installation. Coordinate with Division 25 Contractor for new installation location if necessary.

2.12 Wireless Light Level Sensor

A. Install Wireless Sensor as detailed on drawings.

B. Verify adequate ambient light is provided to charge wireless sensor. Relocate sensor location in coordination with Division 25 Contractor if necessary.

2.13 Touch Screen Panel

A. Install Touch Screen Panel as detailed on drawings. Coordinate mounting height and final location with BAS Contractor.

B. Install Remote Control Processor as detailed on drawings and provide with non-emergency 20A 120V receptacle power.

PART 3 - PRODUCTS

3.1 Installation

A. Install and wire all Addressable Networked Light Management System equipment furnished by the Division 25 Contractor per the manufacturer's instructions.

B. Installation shall include all low voltage wiring and terminations in accordance with the documents provided by the Division 25 Contractor, including wiring and terminations;

1. Between System Support Unit, Energy Control Units, Touch Screen Panels and Network Switch.
2. Between Energy Control Units, Lighting Control Modules, Sensor Interface Modules, Wireless Gateways, Wall Stations and Relay Panels.
3. Between Lighting Control Modules and the luminaire ballasts including 0-10V dimming control wiring.

C. Installation shall include all line voltage wiring and terminations in accordance with the documents provided by the Division 25 Contractor, including wiring and terminations;

1. Between Luminaire Control Modules and lighting loads

2. For Addressable Networked Light Management System component 120V power as detailed on plans.

D. Setting and Labeling

1. Label control modules and emergency power circuits.
2. Set occupancy sensor to lowest setting.

3.2 Programming

A. Programming of the Addressable Networked Light Management System as specified shall be furnished by the Division 25 Contractor.

B. Provide complete and accurate as-built drawings to Division 25 Contractor prior to Addressable Networked Light Management System Check-out and Testing.

3.3 System Checkout and Testing

A. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.

B. Verify that all line and low voltage wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.

C. Demonstrate to Division 25 Contractor 0-10Vdc dimming ballast operation as follows:

1. Open 0-10Vdc control leads to demonstrate that all 0-10Vdc dimming ballasts connected achieve full (100%) light output.
2. Short 0-10Vdc control leads to each other to demonstrate that all 0-10Vdc dimming ballasts connected achieve minimum (typically 5%) light output.
3. Lamp flicker, tiger tails, or irregularities with the 0-10Vdc dimming ballasts are not acceptable. Replace, re-wire or repair 0-10Vdc dimming ballast as required.
4. Lamps shall be operated at full output for 100 continuous hours prior to system check-out and testing.

D. Control system demonstration and acceptance.

1. After tests described in this specification are performed by the Division 25 Contractor to the satisfaction of the Engineer, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test.
2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved.

END OF SECTION

26 22 13 DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 Transformers shall be dry type, air cooled, two winding, insulated, high efficiency units, size and voltage as listed on drawings.

1.2 Construction and testing in accordance with NEMA, IEEE and ANSI Standards. Transformers shall bear the UL label for the specified temperature rise.

PART 2 - PRODUCTS

2.1 Manufacturer Square D, Siemens, Acme, AFP Transformers, Hammond Power Solutions, Federal Pacific, G.E. or Eaton.

2.2 Transformer Construction

A. Core: The magnetic circuit shall be 3 phase core type. Laminations are to be manufactured from non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses; the core shall be grounded by means of a flexible grounding conductor.

B. Coils: Coils shall be wound of continuous copper magnet wire of the barrel wound design.

C. Impregnation: Core and coil with core brackets shall be thoroughly dried followed by impregnation with a silicone varnish or non-hygroscopic thermosetting varnish.

D. Construction: Individual core and coil assemblies shall be mounted adjacent to one another but isolated from transformer case and base by means of vibration isolators. Vertical assemblies one above the other will not be acceptable. The conduit entrance and terminal board shall be located at the bottom of the enclosure. The taps must be accessible when the cover is removed.

E. Taps: Transformers 25 kVA and above shall be equipped with NEMA Standard full capacity 2.5 percent taps:

1. Up to 500 kVA (2) FCAN and (4) FCBN taps

2. Above 500 kVA (2) FCAN and (2) FCBN taps

F. Three phase transformers shall be 480 volt delta primary and 208Y/120 volt secondary.

G. Ground system termination bar for terminating coil, housing and system bonding jumpers and feeder equipment grounds bar shall not be installed on or over ventilation openings.

2.3 Performance:

A. Temperature Rise: Transformers 25 kVA and above shall have Class H (220 degrees C.) insulation system. When the transformer is delivering the full kVA load continuously, the temperature rise shall not exceed a 115 degree C. rise above 40 degrees C. ambient.

B. Short Circuit Strength: Transformers shall be capable of withstanding without injury, stresses caused by short circuits on the secondary with rated voltage applied to the transformer provided the short circuit duration does not exceed time limits as specified by NEMA.

C. Audible Sound Level: Sound levels shall be guaranteed by the manufacturer not to exceed the following when tested per NEMA and ANSI Standards:

kVA	Max. DB
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 – 500	60

D. Efficiency: Minimum efficiency shall be per DOE 10 CFR 431.196 amended standard (min. January 1, 2016 level). Efficiency shall be marked on label.

2.4 Housing: All live parts of the transformer shall be enclosed with a heavy gauge steel enclosure. Ventilation openings shall be protected against falling dirt and drip, shielded against actual touching of live parts. Top of case temperature shall not exceed 35 degrees C. above ambient. The terminal compartment shall be so designed to permit the use of 75 degrees C. wire. Lifting eyes or other provisions for lifting shall be provided.

2.5 Obtain from the transformer manufacturer and submit to the Architect and Engineer, copies of guaranteed performance data on NEMA forms. The minimum efficiency to meet 10 CFR Part 431 Test Procedures. Data shall be based on transformers of identical design to those specified. Test shall be in accordance with 10 CFR Part 431 Test Procedures for Distribution Transformers. Copies of tests shall be included with shop drawings. The data shall include the following:

A. Efficiency at 25 percent, 35 percent, 50 percent, 75 percent and 100 percent.

B. Percent regulation shall be given at 100 percent and 80 percent power factor.

C. Core loss in watts.

D. Conductor loss in watts based on reference temperature 20 degrees C. above the temperature rise of the transformer.

E. Impedance at reference temperature.

F. Sound level.

G. Average temperature rise with 40 degrees C. ambient.

H. Hot spot temperature rise with 40 degrees C. ambient.

2.6 A vibration isolation pad shall be field installed between the transformer enclosure and the concrete base or wall mounting supports, one at each of the four corners. The isolator pad shall be a one-bolt assembly with 0.75 inch minimum thickness neoprene isolation pad, galvanized 16 gauge minimum metal plate bonded to the neoprene pad, rubber isolator washer, flat plated steel washer, plated steel bolt; Eaton B-Line type CNNK, Amber Booth (VMC Group) Shearflex Multilayer or equal. Size isolation pad for transformer weight and mounting configuration.

PART 3 - EXECUTION

3.1 Where indicated as floor set, mount transformer on and bolt to a 4 inch high concrete base furnished by this Contractor. For wall mounted units, provide new factory mounting brackets and all necessary mounting hardware. For ceiling trapeze suspended transformer provide manufacturer supplied kit and suspension hardware.

3.2 Mount each transformer and enclosure on the vibration isolator pad.

3.3 All raceway connections to the transformer shall be made with liquid-tight flexible metallic conduit.

3.4 Clean the inside of the transformer of any debris or dirt before energizing the unit.

3.5 Measure primary and secondary voltages at no load and full building load and make appropriate tap adjustments to within 2 percent of rated voltage.

3.6 Electrical Tests

A. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a megohmmeter with test voltage output as recommended by manufacturer and International Electric Testing Association. Test duration shall be for 10 minutes with resistance tabulated at 30 seconds, 1 minute and 10 minutes. Values less than manufacturers recommendation shall be investigated. Calculate polarization index. The Polarization Index shall not to be less than 1.0.

B. Perform a turns ratio test between windings at all tap portions. Results shall not deviate by more than one-half percent for either adjacent coils or the calculated ratio.

C. Perform winding resistance tests for each winding at nominal tap position.

D. Perform power factor or dissipation-factor tests on all windings in accordance with the test equipment manufacturer's published data. Expected results vary by equipment design, confirm acceptable valves with transformer manufacturer or test equipment manufacturer.

E. Perform individual excitation current tests on each phase in accordance with established manufacturer's procedures. Typical test data pattern for a three-legged core is two similar readings and one lower current reading.

F. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading. Voltage shall be in agreement with nameplate data.

G. Provide copy of test report to Engineer.

3.7 Temporary heating: Apply temporary heating inside the enclosure according to manufacturer's written instructions throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

END OF SECTION

26 24 13 DISTRIBUTION SWITCHBOARD (BELOW 600 VOLTS)

PART 1 - GENERAL

1.1 Switchboard shall be free standing, indoor, manufactured and tested in accordance with the latest applicable standards of UL, IEEE and NEMA and shall be a single coordinated assembly of a recognized manufacturer, assuming unit responsibility for the complete assembly.

1.2 The switchboard shall be UL listed and labeled for UL 891 and shall meet NEMA PB2 standards.

1.3 Refer to drawings for accessibility requirements for each switchboard - front, rear, end/or a combination of each.

1.4 The switchboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse/circuit breaker combinations indicated on the drawings.

PART 2 - PRODUCTS

2.1 Manufacturer - Square D, Siemens, Eaton, or G.E.

2.2 The switchboard shall be totally enclosed, dead front, free standing, front and rear aligned with front accessibility only required. The switchboard shall be Type 1 General Purpose. The framework shall be of UL gauge steel and secured together to support all coverplates, bussing and component devices during shipment and installation. Formed removable closure plates shall be used on the front, rear and sides. All closure plates are to be single tool, screw removable. Ventilation shall be provided when required. Each section shall include a single-piece removable top plate.

2.3 All painted parts shall be pretreated and provided with a corrosion-resistant, UL listed acrylic baked paint finish.

A. The paint color shall be #61 medium light gray per ANSI standard Z55.1.

2.4 The entire switchboard shall be suitable for operation at the available fault current indicated on the drawings. The switchboard shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing, switchboard main disconnect(s), and switchboard branch circuit devices. Total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated System. When series rating applied a label shall be provided per NEC 110.22 (c).

2.5 The switchboard through-bus shall be silver-plated copper. The switchboard bussing shall be of sufficient cross sectional area to meet UL Standard 891 for temperature rise. The through bus shall be rated full capacity of the main switch or breaker frame size of the main overcurrent device or the ampacity indicated on the drawings and extend the full length of the switchboard. The through-bus shall be 100 percent rated. Include provisions for extending bussing through future splicing of additional sections from both / either end. The neutral bus shall be 100 percent rated.

2.6 The switchboard distribution section bus shall be full height, of the same material as the through bus and shall be rated as indicated on the drawings or sized for the devices installed and for all future devices that may be installed in that section. The section neutral plate shall be 100 percent rated and provided with lugs for the devices installed and future specified devices.

2.7 The ground bus shall be copper and run continuous through each section; securely bolt to all structures in the assembly. Bus shall be sized per UL Standard 891 and shall have cable clamps suitable for making all ground connections. Provide a removable link between the neutral bus and ground bus. Connect all ground conductors including ground bars in bus duct to ground bus in switchboard.

2.8 Provide heavy duty metering instruments designed especially for switchboard use. Mount all such instruments on a front hinged door for access to internal wiring connections. Provide shorting terminal blocks on all CT circuits. All wiring passing across the door hinge shall be extra flexible type. The following items shall be included:

A. One digital power meter with current (each phase), voltage (phase to neutral and phase to phase), powerfactor, THD, instantaneous, minimum, maximum, kWh, and 15-minute kWD demand readings, with local digital display. Digital power meter utilizes standard switchgear style CT's with 5A secondaries. Metering voltage input may be direct (no PT's required) up to 600 VAC, or standard switchgear style PT's up to 1.7 MV. Square D model PM5563 with local display or equal by Eaton, Siemens, G.E. or Electro Industries.

B. One digital power meter with advanced power monitoring device similar to Square D PowerLogic Circuit Monitor Model PM8244 with full instrumentation, disturbance monitoring sag/swell detection (1/2 cycle detection), waveform capture, alarm relay functions, accuracy class IEC 60687, 0.5 S and ANSI Class 12.20 accuracy class 0.2, on-board data logging, downloadable firmware, date/time for each min/max, local digital display, RS-485 communications built-in, and optional Ethernet communications is acceptable; equal by Eaton, Siemens, G.E. or Electro Industries.

C. Digital type electronic, solid state, microprocessor based integrated metering, protection and control system; similar to Square D ION9000 with required revenue grade current and potential transformers and following features:
1. Ampere readout for each phase.
2. Voltage readout for each phase and between phases
3. Watt readout
4. VARS readout
5. Power factor readout
6. Demand watt readout
7. Frequency readout
8. Energy (watt-hour) readout
9. Total harmonic readout up to 63rd order harmonics or 2 percent accuracy
10. kW demand 15-minute interval
11. Trip indicator and alarm
12. Transient wave form capture
13. Capabilities to remote monitor all items listed above over campus network system. All meters shall be networked together on a single network, network supplied by meter manufacturer, such that campus monitoring system can interface all meters with one integrator and one connection to the metering network.

D. Provide a monitoring system in each main switchboard. Furnish and install interconnect wiring between each monitor to allow observation of data on a per switchboard basis or to totalize data for both. System shall be capable of expansion for totalizing two future additional monitoring systems. All data including totalizing data shall be read at the monitors and not require separate PC/terminal.

2.9 Coordinate shipping splits to suite job site conditions. Include removable type lifting hooks and a wooden skid to permit unloading and rolling into its final location in the building.

2.10 Main breakers and tie breakers shall be solid state trip molded case 100 percent rated type including the following:

A. Individually mounted and bussed.

B. Adjustable long time, short time and instantaneous trip. For frame sizes larger than 200 amperes the trip units shall be changeable. Minimum interrupting rating shall be 65,000 amp.

C. Ground fault protection on the main and feeder breakers utilizing zone selective interlocking. Submit complete descriptive drawings and information along with coordination study indicating recommended ground fault relay and breaker trip settings.

2.11 Switchboard shall contain sub-distribution type breaker panels which contain breakers group mounted complete with bus bars in an integrated assembly. Breakers shall be molded case type, thermal-magnetic protection, 80 percent rated.

2.12 Refer to "Identification for Electrical Systems" section for nameplate requirements. Each item of the switchboard assembly shall be identified with engraved laminated nameplates.

2.13 Factory testing shall be completed on assembled unit verifying proper operation of components and wiring before shipment. Two (2) copies of factory test reports shall be provided before equipment delivery.

2.14 Provide a Transient Voltage Surge Suppressor (TVSS) on the load side of the main switch; refer to Section 26 43 13. The TVSS shall be factory mounted and wired with remote status panel in front hinged door of that switchboard section. All wiring passing across the door hinge shall be extra flexible. Barrier off section from switchboard bussing. Serve TVSS from an adjacent fused switch or breaker, refer to drawings and TVSS manufacturer's recommendations; fuse size and type as recommended by the TVSS manufacturer shall be shown on the switchboard shop drawing submittal. Circuit conductors shall not exceed 18 inches in length.

PART 3 - EXECUTION

3.1 The entire metal enclosed assembly shall be bolted to a front and rear base channel set level on concrete base. A removable metal closer plate, which seals the opening between front and rear channels, shall be furnished at each end of the switchboard.

3.2 Provide 4 inch high concrete housekeeping base below the switchboard. Concrete to be 3000 pound test with #4 rebar 12 inches on center. Chamfer top and vertical edges.

3.3 Adjust circuit breaker trip and time delay settings to values as indicated in coordination study.

3.4 Provide engraved label with the nominal system voltage, available fault current clearing time of main OCPD and date label applied near the main OCPD from information in the Protective Device Study or furnished by Owner.

3.5 Provide sign at the service entrance indicating type and location of on-site legally required standby source per NEC 701.7 and emergency source per NEC 700-7 and optional standby per NEC 702.7.

3.6 Provide special tools for operation of equipment.

3.7 Perform ground fault protection device pick-up tests using primary injection. Measure time delay of the ground fault protective device at a value equal to or greater than 150 percent of pick-up value. Provide test report to Engineer.

3.8 Interconnect the zone selection in the switchboard and any downstream distribution circuit breakers equipped with zone selective interlocking.

3.9 Perform primary injection tests for zone selective interlock system after settings are applied to verify proper operation. Provide test results. Submit report to Engineer.

3.10 Connect metering to campus monitoring system. Provide network interface connection. Connect all meters in distribution equipment.

3.11 Post a durable copy of the “as-left” relay settings and fuse ratings in a convenient location within each switchboard assembly. Deliver four additional copies of the settings and fuse ratings to the Engineer.

3.12 Apply labels with setting determined from Arc-Flash Study. Test the Arc-Flash Reduction Maintenance System.

END OF SECTION

26 24 14 INTEGRATED FACILITY SYSTEM SWITCHBOARD (IFSS)

PART 1 - GENERAL

1.1 Integrated Facility System Switchboard (IFSS) shall be free standing, indoor, manufactured and tested in accordance with the latest applicable standards of UL, IEEE and NEMA and shall be a single coordinated assembly of a recognized manufacturer, assuming unit responsibility for the complete assembly.

1.2 The IFSS shall be a low voltage distribution switchboard utilizing integrated panelboards, automatic transfer switches, transformers and other equipment as indicated on the drawings and specified herein.

1.3 The IFSS shall be UL listed and labeled for UL 891 and shall meet NEMA PB2 standards.

1.4 Refer to drawings for space and accessibility requirements for each IFSS – equipment shall be front accessible only.

1.5 The IFSS manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse/circuit breaker combinations indicated on the drawings.

1.6 The manufacturer of the complete assembly shall be the manufacturer of the major components within the assembly, unless otherwise specified. The manufacturer of the IFSS shall have produced similar equipment for a minimum of five (5) years.

1.7 Warranty

A. Manufacturer shall warrant the complete IFSS free from defects in materials and workmanship for a period of two (2) years from the date of approval of Certificate of Contract Completion by the Owner.

PART 2 - PRODUCTS

2.1 Manufacturer – Eaton, Square D, Siemens or G.E.

2.2 All painted parts shall be pretreated and provided with a corrosion-resistant, UL listed acrylic baked paint finish.

A. The paint color shall be #61 medium light gray per ANSI standard Z55.1.

2.3 The entire IFSS shall be suitable for operation at the available fault current indicated in the fault current analysis. The IFSS shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing and devices. Total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated.

2.4 The IFSS bus (where applicable) shall be silver-plated copper. The IFSS bussing shall be of sufficient cross sectional area to meet UL Standard 891 for temperature rise. The bus shall be rated the ampacity indicated on the drawings and shall be 100 percent rated. The neutral bus shall be 100 percent rated.

2.5 Enclosures

A. Enclosure: Type 1 - General Purpose.

1. Enclosures shall be constructed in accordance with UL 891 requirements, totally enclosed, dead front and free standing.
2. Sections shall be aligned front and rear with front accessibility only required.

3. The framework shall be of UL gauge steel and secured together to support all coverplates, bussing and component devices during shipment and installation.
4. Formed removable closure plates shall be used on the front, rear and sides. All closure plates are to be single tool, screw removable.
5. Enclosure shall be painted on all exterior surfaces per requirements of 2.2.
6. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
7. Each lineup shall consist of the required number of vertical sections bolted together to form a rigid assembly.
8. Ventilation shall be provided when required.
9. Each section shall include a single-piece removable top plate.
10. Sections shall allow for top and/or bottom cable entry and exit.
11. Single section shipping splits shall not exceed 48 in. (1218 mm) wide maximum.

2.6 Fronts

A. Trim front shall meet strength and rigidity requirements of applicable UL standards.

B. The manufacturer shall provide a hinged door with a key lock over the deadfront of each panelboard interior.

C. All panelboards shall have door-in-door construction.

D. All individually mounted circuit breakers and/or equipment space compartments shall have a full width hinged door. The hinged door shall be secured with captive screws.

E. The transformer front cover shall be secured with screws.

F. Directory cardholder with typed circuit directory shall be included with each panel interior.

2.7 Wiring/Termination

A. Factory installed type THHN copper power cables shall electrically connect the transformer to the power panel interior or lighting and appliance panel interiors in the section or lineup.

B. All control wire shall be type SIS bundled and secured with nylon ties.

C. When shipping splits are required, power cables shall be cut to length, stripped, labeled and rolled back in one of the adjacent enclosures. Control wiring that bridges shipping splits shall be provided with male/female connectors.

D. Mechanical type terminals shall be provided for all line and load terminations suitable for the specified conductors.

E. Lugs shall be provided for connection of all grounding conductors.

F. Edit components of the IFSS in below sections as required for the specific project.

2.8 Panel Interiors

A. Shall be of same manufacturer as the IFSS.

B. Panel interiors shall be flush mounted with the front of the enclosure to allow easy access to line and/or load conductor’s entering/exiting top or bottom. Recessing the panel interior more than 4 inches from the front of the enclosure will not be acceptable.

C. Lighting and Appliance panel interiors shall be circuit breaker type rated 240 VAC or 480Y/277Vac maximum as indicated on the drawings. Refer to specification section 26 24 16 for panelboard requirements.

2.9 Individually Mounted Circuit Breakers

A. Shall be of same manufacturer as the IFSS.

B. Individually mounted molded case circuit breaker cell shall have a door to access the wiring compartment.

C. Individually mounted molded case circuit breaker handles shall be accessible from the front of the section without opening a door.

D. Refer to specification section 26 28 17.

2.10 Surge Protective Devices (SPD's)

A. Integrated surge protective devices shall be Listed and Component Recognized in accordance with UL 1449 to include highest fault current category. SPD shall be UL 1283 listed.

B. SPD's in the lighting and appliance panel interiors shall be branch breaker connected.

C. Refer to specification section 26 43 13 for SPD requirements.

2.11 Integrated Transformers

A. Shall be of same manufacturer as the IFSS.

B. Transformer(s) shall be factory installed in a freestanding enclosure as shown on the associated drawings.

C. Refer to specification section 26 22 13 for transformer requirements and drawings for KVA requirements.

D. Adequate ventilation shall be provided within the IFSS, fan cooled transformers will not be allowed.

2.12 Automatic Transfer Switches

A. The IFSS manufacturer shall integrate low voltage automatic transfer switches into the IFSS assembly as indicated on the drawings.

B. Refer to specification section 26 36 23 for automatic transfer switch requirements, including acceptable manufacturers.

2.13 The ground bus shall be copper and run continuous through each section; securely bolt to all structures in the assembly. Bus shall be sized per UL Standard 891 and shall have cable clamps suitable for making all ground connections.

2.14 Coordinate shipping splits to suit job site conditions. Include removable type lifting hooks and a wooden skid to permit unloading and rolling into its final location in the building.

2.15 Provide each IFSS with instruction bulletins, renewal parts lists, where applicable, and maintenance information for inclusion in the O & M manuals.

2.16 Refer to "Identification for Electrical Systems" Section 26 05 53 for nameplate requirements. Each item of the IFSS assembly shall be identified with engraved laminated nameplates.

2.17 A short circuit and coordination study complete with curves shall be furnished by the IFSS manufacturer which demonstrate proper interrupting ratings and coordination between devices. Provide any recommended settings for devices. In addition to the Short Circuit and Over-Current Coordination Studies, include Arc Flash Evaluation Studies using the NFPA 70E or IEEE 1584 Standard to comply with NEC paragraph 110.16. Provide in report form, the results of the calculations and install labels/marking on IFSS that are likely to require examination, adjustment, servicing, or maintenance while energized.

Note: These studies must be submitted with the shop drawings. Shop drawings cannot be reviewed without these studies. The Contractor shall make all proper settings before energizing the equipment.

PART 3 - EXECUTION

3.1 The manufacturer shall provide scaled drawings for all electrical rooms in the building, indicating layout and clearances for all IFSS and other electrical equipment in the room. Drawings and elevations shall indicate overall equipment dimensions. Shop drawings cannot be reviewed without detailed manufacturer drawings confirming that all proposed electrical equipment can be installed in the available space, with code required clearances.

3.2 Each IFSS shall be handled, stored and mounted in accordance with the manufacturer's instructions. Provide two (2) copies of all relevant instructions to the installing contractor.

3.3 The entire metal enclosed assembly shall be bolted to a front and rear base channel set level on concrete base. A removable metal closer plate, which seals the opening between front and rear channels, shall be furnished at each end of the IFSS.

3.4 Provide 4 inch high concrete housekeeping base below the IFSS. Concrete to be 3000 pound test with #4 rebar 12 inch on center. Chamfer top and vertical edges.

3.5 Field verify tightness of bolted connections and device connections using calibrated torque wrench or torque screwdriver per manufacturers written specifications.

3.6 Adjust circuit breaker trip and time delay settings to values as indicated in the coordination study.

END OF SECTION

26 24 16 A PANELBOARDS

PART 1 - GENERAL

1.1 Each panelboard shall comply with all applicable codes, recommended practices and standards of IEEE, NEMA and UL. Panelboard shall be UL labeled.

1.2 The panelboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and the fuse/circuit breaker combinations indicated in the fault current analysis.

PART 2 - PRODUCTS

2.1 Panelboard Types

A. 240 Volt (Maximum) AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100 amp shall be minimum 10,000 amp, I.C. rated with adequate rating to interrupt the available fault current, for a fully rated system.
2. GFCI breaker – UL Class A (5 milliampere sensitivity, combination type). Ground fault circuit protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection. Space required in panelboard shall be same as standard single pole circuit breaker.
3. Panelboard by Square D Type “NQ”, G.E. Type “AQ”, Eaton “Pow-R-Line PRL2” or Siemens P2 series.

B. 277/480 Volt AC Panelboards

1. Breakers shall be “bolt-on” type and in sizes thru 100 amps shall be minimum 14,000 amp I.C. rated with adequate rating to interrupt the available fault current; for a fully rated system.
2. Panelboards by Square D type "NF" G.E. type “AE”, Eaton “Pow-R-Line PRL2”, or Siemens P2 Series.

C. Circuit Breaker Distribution Panelboard

1. Removable front with hinged door. Bussing braced for the available fault current; 1200 amp bussing and less.
2. Main and branch breakers shall be solid state trip molded case type with long time, short time, instantaneous trip and ground fault protection – with zone interlocking with the main solid state trip molded case breaker. Breakers shall be molded case type, thermal-magnetic protection, 80 percent rated.
3. Power and distribution panelboards by Square D "I-Line", Siemens "P4 Series", Eaton “Pow-R-Line PRL4” or G.E. Spectra Series.

D. Fusible Switch Distribution Panelboard - Completely front accessible, wall mounted with adequate rating to withstand and interrupt the available fault current.

1. Switches shall be quick-make, quick-break mechanisms with grid type arc quenchers and silver alloy contacts. Switch handles interlocked to prevent opening door unless switch is in open position. Doors equipped with padlock hasp. Fuseholders for Class "R" rejection type fuses equal to Bussmann "Low-Peak".
2. Manufacturer - Square D type "QMB", Siemens "P5 Series" Eaton “Pow-R-Line PRL4” or G.E. Spectra Series.

2.2 Refer to "Identification for Electrical System" Section 26 05 53, for nameplate requirements.

2.3 Refer to Section 26 24 17 “Panelboard with Surge Protective Device” for panelboards with surge suppression and filter system built into panelboard enclosure.

2.4 General Construction

A. Code gauge, galvanized steel tubs with minimum 4 inches clear gutters all sides. Minimum tub width 20 inches, depth 5 inches.

B. Locking type reinforced doors with concealed hinges; equipped with directory card holder on inside of door; enameled finish. Doors over 48 inches high shall have 3 point latch and vault locks. All locks shall be master keyed cylinder, keyed alike.

C. For service entrance panelboards, provide a barrier so no service terminals or bus bar is exposed when servicing load terminal.

D. Permanent individual breaker pole numbers affixed adjacent to each breaker in a uniform position consisting of a stamped metallic or painted numeral.

E. Bussing shall be copper.

F. Branch circuit panelboard tubs and fronts shall be sized to have 225 amp bussing and accommodate 42 poles unless indicated otherwise on the drawings. Furnish number of breakers shown.

G. A neutral bar assembly (when required) and separate ground bar assembly shall be provided. Each assembly shall be copper and have the adequate number of terminals, of sufficient size and type of anti-turn solderless lugs. Each assembly shall have conductor terminal screwdriver slots facing the front of the panel. Bond ground bar assembly to panel cabinet.

H. Terminals for feeder conductors to the panelboard mains, neutral, ground and branch circuit breaker wiring shall be suitable for the type of conductor specified.

I. Main or sub-feed breakers shall be provided where indicated. Shunt trip breakers where specified, shall have 120 volt coil and coil clearing contacts.

J. Circuit breakers shall be bolted on type and where more than one pole is used, they shall employ a common trip.

K. Breakers in panelboards used for switching of 120 and 277V. fluorescent lighting circuits shall be rated for switching duty UL "SWD" or “HID” type; for switching high-intensity discharge lighting shall be “HID” type.

L. Breakers used for protection of heating, air conditioning and refrigeration equipment shall be UL "HACR" type.

2.5 All panelboards serving life safety loads are to have a SPD connected to each panel. Provide branch circuit breaker and SPD refer to specification section 26 43 13 Surge Protective Devices.

2.6 The panelboards and breakers shall be adequately rated for the available fault current as indicated on the drawings and in the specifications. The total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated System.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6 feet 0 inches above floor. Coordinate location of recessed panels so they are accessible and to avoid interference with other equipment and trades. Mount and anchor floor set panelboards on a 4 inch high concrete pad furnished by this Contractor.

3.2 The position of breakers in each panel shall be arranged in the field for sequence phasing by this Contractor to best suit wiring conditions and balancing of phases. Fill in, typewritten, the directory of each branch circuit panelboard.

3.3 For multi-wire branch circuit group circuit breaker together and provide breaker handle tie. Group conductors together with tie-wrap.

3.4 Adjust circuit breaker trip and time delay settings to values as indicated in the coordination study.

END OF SECTION

26 24 17 PANELBOARD WITH SURGE PROTECTIVE DEVICE

PART 1 - GENERAL

1.1 Each panelboard shall comply with all applicable codes, recommended practices and standards of IEEE, NEMA and UL. Panelboard and panelboard extension containing the Surge Protective Device (SPD) shall be UL labeled.

1.2 The panelboard manufacturer shall supply equipment which is rated, listed, and labeled for the available short circuit current and circuit breaker combinations indicated on the drawings.

1.3 The basic panelboard with integral surge protective device (SPD), shall comply entirely with Section 26 24 16, Panelboard, have breakers fully interchangeable and by the same manufacturer as those breakers furnished for this project under Section 26 24 16.

PART 2 - PRODUCTS

2.1 For panelboard and breaker types refer to Specification Section 26 24 16 Panelboard approved manufacturers are Square D, Siemens, Eaton and G.E.

2.2 Refer to "Identification for Electrical Systems", section for nameplate requirements.

2.3 Refer to Section 26 43 13 “Surge Protective Devices (SPD’s) for Low-Voltage Electrical Power Circuits” for additional requirements for surge suppression and filter system and acceptable Edit scope for types of panelboards required.

2.4 General Construction

A. Code gauge, galvanized steel tubs with minimum 4 inches clear gutters all sides. Minimum tub width 20 inches, depth 5 inches.

B. Locking type reinforced doors with concealed hinges; equipped with directory card holder on inside of door; enameled finish. Doors over 48 inches high shall have 3 point latch and vault locks. All locks shall be master keyed cylinder, keyed alike.

C. Integral SPD is defined as a device that is placed directly inside a completely barriered off section of the panelboard by the panelboard manufacturer (panelboard or SPD manufacturer or UL recognized OEM) or by the use of a panelboard extension that is provided directly from the SPD manufacturer. In any case, the SPD shall be in a separate barriered off section so that conductive smoke and ionized gases from a failed SPD will not cause flashover within the panelboard.

D. The SPD shall be connected to the panelboard through a 30-amp breaker provided by the panelboard manufacturer. The SPD shall be easily accessible without the need to remove the panelboard dead-front shield, exposing live bus bar.

E. If panelboard extension is used it shall include an enclosure backbox with knock-outs for feeder and branch circuit conduit and shall have similar dimensions as the panelboard tub.

F. The front cover of the panelboard extension shall be of the same width as the panelboard cover. Note: An option is to build an oversized panelboard cover that will extend over the SPD enclosure or have a separate hinged door over the SPD section with matching key and lock.

G. The panelboard extension shall provide sufficient space to allow for feeders and/or branch circuits to pass through the extension without affecting the operation of the SPD.

H. The SPD lamps, indicators and audible device available on the panelboard extension shall be protected from tampering.

I. The panelboard cover shall be secured to the SPD enclosure with a tamper-proof means. For example, special tools may be required to remove this cover.

J. Permanent individual breaker pole numbers affixed adjacent to each breaker in a uniform position consisting of a stamped metallic or painted numeral.

K. Bussing shall be copper.

L. Branch circuit panelboard tubs and fronts shall be sized to have 225 amp bussing and accommodate 42 poles unless indicated otherwise on the drawings. Furnish number of breakers shown.

M. A neutral bar assembly (when required) and separate ground bar assembly shall be provided. Each assembly shall be copper and have the adequate number of terminals, of sufficient size and type of anti-turn solderless lugs. Each assembly shall have conductor terminal screwdriver slots facing the front of the panel. Bond ground bar assembly to panel cabinet.

N. Terminals for feeder conductors to the panelboard mains, neutral, ground and branch circuit breaker wiring shall be suitable for the type of conductor specified.

O. Main or sub-feed breakers shall be provided where indicated. Shunt trip breakers where specified, shall have 120 volt coil and coil clearing contacts.

P. Circuit breakers shall be bolt-on type and where more than one pole is used, they shall employ a common trip.

2.5 The panelboards and breakers shall be adequately rated for the available fault current as indicated on the drawings and in the specifications. The total breaker and fuse short circuit and overcurrent protective system shall be U.L. Fully Rated System.

PART 3 - EXECUTION

3.1 Mount top of wall mounted cabinets 6 feet 0 inches above floor. Coordinate location of recessed panels so they are accessible and to avoid interference with other equipment and trades. Mount and anchor floor set panelboards on a 4 inch high concrete pad furnished by this Contractor.

3.2 The position of breakers in each panel shall be arranged in the field for sequence phasing by this Contractor to best suit wiring conditions and balancing of phases. Fill in, typewritten, the directory of each branch circuit panelboard.

3.3 For multiwire branch circuits, group circuit breakers and provide a handle tie. Group conductors together with tie-wraps.

END OF SECTION

26 27 13 ELECTRICITY METERING / BUILDING SERVICE - SECONDARY

PART 1 - GENERAL

1.1 The primary electric service to the site will run overhead to a riser pole and drop underground to the pad-mounted transformer; secondary service extends to the building. Scope includes primary underground ducts, trenching, handholes, manholes, pad for transformer, underground secondary ducts and cable to the location of the metering and secondary distribution unit and provisions for metering.

1.2 Division of Work

A. The Power Company will furnish and install the following items: U Gard riser, primary cable, primary terminations, meter, metering transformers, pad-mounted transformer, terminal riser pole, lightning arresters, cutouts and H.V. warning sign.

B. The Power Company will furnish the following material which shall be installed by this Contractor: the meter base, current transformers and voltage transformer.

C. The Contractor shall furnish and install meter cabinet and current and voltage transformer cabinet and all secondary conductors and make all secondary terminations.

D. Coordinate metering and service entrance requirements with the Power Company.

E. The Contractor shall install 2 inch conduit from the metering enclosure to meter location.

F. Aid-to-Construction charges (charges by the Power Company for their work, if required) shall be included in this Contractor's bid price. Indicate the breakout cost on the Form of Proposal/Bid Form.

PART 2 - PRODUCTS

2.1 The electric service ducts shall be rigid PVC encased in a 3 inch envelope of 3,000 psi, 28 day strength concrete. The concrete shall be tinted by spraying red dye after pouring. All conduit shall be complete with properly bushed terminals, long sweep bends, etc. All excavation, backfill and tamping shall be included in this work. Conduit riser on pole shall be rigid galvanized steel, with proper adapter to PVC.

2.2 Transformer pad shall be constructed of 3,000 psi concrete by this Contractor to Power Company specifications.

2.3 Meter and transformer cabinets shall meet power company requirements and be sufficient wiring space for required service conductors.

PART 3 - EXECUTION

3.1 Install pad and metering accessories per Power Company requirements.

3.2 Pull mandrel thru each conduit to ensure against foreign objects remaining inside.

3.3 Contractor to obtain a "new service packet" from the Power Company and work with Engineer and Owner to completely fill out and send to Power Company immediately after contract award to ensure new service can be turned on in timely manner.

END OF SECTION

26 27 16 ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 Work includes all special cabinets and enclosures; equipment shall conform to requirements of N.E.C. and shall be UL labeled.

PART 2 - PRODUCTS

2.1 Telephone Miscellaneous Cabinets

A. Indoor cabinets shall match panelboard finish and construction and shall be manufactured by Siemens, Square D, Eaton, Tanco Inc., or G.E.

B. Outdoor enclosures shall be manufactured by Hoffman, Rittal Corp., Milbank, Tanco Inc. or Hennessy Products.

C. Provide backboard for mounting equipment, 0.75 inch plywood. Paint matte white.

2.2 Indoor Cabinets - NEMA 1

A. Cabinets shall be galvanized code gauge steel, finished gray enamel or manufacturer's standard equivalent finish, of sizes shown with flush painted hinged door and master keyed cylinder locks keyed to match panelboard locks. Cabinets in finished areas shall be designed for flush mounting with separable front overlapping flange. Cabinets in concealed areas shall be surface mounted types.

B. Each cabinet shall be equipped with a 0.75 inch thick waterproof fir plywood backboard painted gray.

2.3 Outdoor Enclosure - Single Door - Small

A. The enclosure shall meet or exceed the requirements of a NEMA 3R or 4X rating and shall be UL listed.

B. The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy; 0.125 inch thick. The door opening shall be double flanged on all four sides.

C. The cabinet door shall be a minimum of 80 percent of the front surface area and shall be gasketed (UL 508 table 21.1) with weather tight seal between the cabinet and door.

D. The hinges shall be continuous and made of 0.063 inch stainless steel with 0.120 inch diameter stainless steel hinge pins.

E. The latching mechanism shall be a slam type with Corbin #R357SGS, or equal lock with keyhole cover for NEMA 3R enclosure; for NEMA Type 4X enclosure, the latch shall be weather tight quarter turn type. Furnish 2 keys with each lock.

F. Provide aluminum back panel 0.125 inch thick complete with all mounting hardware.

G. Cabinet finish shall be standard grey color unless indicated otherwise.

H. Cabinet mounting plates shall be located at bottom and top of enclosure for either in wall mounting or surface mounting.

2.4 Outdoor Enclosure - Single or Double Door - Large

A. The enclosure shall meet or exceed the requirements of a NEMA 3R or 4X and shall be UL listed.

B. The cabinet and door shall be constructed from 5052-H32 sheet aluminum alloy; 0.125 inch thick. The cabinet shall have sloped top to prevent accumulation of water on its top surface. The door opening shall be flanged on all four sides. Provide door restraint to prevent door movement in windy conditions. Provide double doors where indicated or required to meet UL requirements.

C. The cabinet door shall be a minimum of 80 percent of the front surface area and shall be gasketed (UL 508 table 21.1) with weather tight seal between the cabinet and door.

D. The hinges shall be continuous and made of 0.093 inch stainless steel with 0.250 inch diameter stainless steel hinge pins.

E. The latching mechanism shall be a 3-point draw roller type; 180 aluminum center catch and pushrods (0.25 by 0.75 inch aluminum, minimum); nylon rollers, stainless steel operating handle with 0.75 inch diameter shank with provisions for padlocking.

F. NEMA 3R enclosures shall have Corbin 1548-1 lock or equivalent; furnish 2 keys. NEMA 3R enclosures requiring ventilation shall be provided with louvered vents in the front door with a removable air filter. NEMA 3R enclosures shall be provided with solid bottom.

G. Provide aluminum back panel complete with all mounting hardware.

H. Cabinet finish shall be standard grey color unless indicated otherwise.

I. Provisions shall be included for wall mounting, pad-mounting.

J. Provide accessory feet for free-standing mounting.

PART 3 - EXECUTION

3.1 Mount the cabinets and enclosures as indicated on the drawings and in accordance with manufacturer's instructions.

3.2 Mount top of wall mounted cabinets 6 feet-0 inches above floor. Coordinate location of recessed cabinets so they are accessible and to avoid interference with other equipment and trades.

3.3 Mount and anchor floor set enclosures on a concrete pad furnished by this Contractor. Indoor pads shall be 4 inches high; outdoor pads shall be steel reinforced as indicated on the drawings.

3.4 Provide the concrete base for the outdoor enclosure. Pad shall be minimum 10 inches thick, 4000 pound test concrete with #4 rebar 12 inches on center each way in center of pour. Pad shall extend 6 inches past enclosure on all four sides with chamfered edges. Form sleeves in pads for conduit entry and place conduits prior to pouring. Pad shall be 3 inches above and 7 inches into finished grade. Over excavate and provide a 12 inch thick compacted pea gravel sub-base below pad.

3.5 Refer to "Identification for Electrical System" Section for nameplate requirements.

END OF SECTION

26 27 26 WIRING DEVICES AND COVERPLATES

PART 1 - GENERAL

1.1 Wiring devices are identified on the drawings per legend symbols or as specifically noted. Receptacles are identified in the legend by NEMA configuration numbers only. Catalog numbers from acceptable manufacturers for the common wiring devices shall be as listed herein. Catalog numbers are not listed for all devices. Other devices, such as clock hanger outlets, etc. shall be furnished by one of the manufacturers listed and shall be equal in quality to the device series listed.

1.2 When shop drawings are required for wiring devices and coverplates, the submittal shall be comprehensive for all wiring device configurations listed in the legend and for devices specifically noted on the drawings.

PART 2 - PRODUCTS

2.1 Extra hard use specification grade receptacles shall be listed by Underwriters Laboratories, Inc. Receptacles shall be minimum 20-ampere, 125 volt, NEMA configuration 5 20R and white in color unless noted otherwise. Where identified on drawing that receptacle is controlled a device of same design to be furnished but with controlled symbol marking.

Acceptable Manufacturer	Single	Duplex	Ground Fault	WR GFCI	Isolated Ground	Tamper Resistant
Eaton	5361	AH5362	SGF20	WRSGF20	AHIG5362	TR5362
Bryant	5361	BRY5362	GFRST20	GFWRST20	BRY5362IG	BRY5362TR
Hubbell	HBL5361	HBL5362	GFR5362SG	GFR5362SG	IG5362	HBL5362TR
Leviton	5361	5362S	G5362WT	G5362WT	5362IG	5362SG
P&S	5361	5362A	2095	IG5362		TR5362

2.2 Standard specification grade receptacles shall be listed by Underwriters Laboratories, Inc. and shall be minimum 20-ampere, 125 volt, NEMA configuration 5 20R and white in color unless noted otherwise. Where identified on drawing that receptacle is controlled a device of same design to be furnished but with controlled symbol marking.

Acceptable Manufacturer	Single	Duplex	Ground Fault	Isolated Ground	WR GFI	Tamper Resistant
Eaton	5351	5352	SGF20	IG5362	WRSGF20	TR5362
Bryant	5351	5352	GFRST20	BRY5362IG	GFWRST20	CBRS20TR
Hubbell	HBL5361	5352A	GFRST20	IG5352	GFFIWRST20	HBL5362TR
Leviton	T5020	5842	G5362WT	5362IG	G5362WT	TD63
Legrand	5351	CRB5362	2095	IG6300	2095TRWR	TR63

2.3 Receptacles installed in a damp or wet location shall be a listed weather-resistant (WR) type.

A. Receptacle shall be installed in a listed weatherproof enclosure, whether or not the attachable plug cap is inserted.

2.4 Provide GFCI devices as shown on drawings and in compliance with NEC 210.8 for type and location. Where GFCI receptacle devices not available at rating required a GFCI protection device to be provided. Bender Lifeguard series.

2.5 Tamper-Resistant Receptacles. All 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles in the following areas shall be listed tamper-resistant receptacles.

A. Dwelling units

B. Guest rooms and guest suites of hotels and motels

C. Child care facilities

D. Preschools and elementary education facilities

E. Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities

F. Gymnasiums, skating rinks, auditoriums and airport waiting areas

G. Dormitories

2.6 Transient voltage surge suppressors (SPD-ANSI/IEEE Category A and B), UL 1449 suppression (clamping) rating of 400 V, 3 mode protection (LN/LG/NG) for 120 V branch circuits:

A. Duplex receptacles, 120 V, 20 A shall be LeGrand 5362-ISP, Hubbell HBL5362ISA, Leviton 5380-I, Bryant SP53-TIGIA or Eaton 5350S. Receptacle to be listed UL 1449 Type 3.

B. Suppression strip with a heavy duty 6 ft. 14-2 AWG power cord, 6 electrical NEMA 5-15R 120V, 15 A outlets, computer grade on/off 20 A switch, resettable circuit breakers, internal thermal fusing, hybrid suppression circuit and comprehensive diagnostics. Strip to be listed UL 1449 Type 3.

EFI Electronics Corp. - Model 453 (15 A Overload Protection)
Wiremold Sentrex "High Performance" - Model M6S (10 A Overload Protection)
Joslyn Electronic Systems - Model 1203-03 (15 A Overload Protection)
Pass and Seymour - Model PS7 (15 A Overload Protection)
Hubbell Model HBL6PS350A (15A Overload Protection)
Leviton Model 5300-PS

2.7 Provide a device plate to suit each particular application. Cover all empty outlet boxes with a blank plate. Coverplates shall be manufactured by Pass and Seymour, Hubbell, Cooper, Bryant, Leviton or Mulberry; Taymac is an acceptable manufacturer for weatherproof non-metallic coverplates Multi-Mac Series, “While-In-Use” type, 3.5 inches depth, ‘Extra Duty’, opaque grey, locking tab. Provide jumbo size plates for outlets installed in masonry walls.

2.8 In finished spaces, wall plates shall be nominal .032 inch thick, made of 302 high nickel stainless steel with brushed satin finish and beveled edges. Screws shall be metal with countersunk heads and finished to match plates. Sectional plates will not be permitted.

2.9 In finished spaces, wall plates shall be unbreakable lexan or nylon, non-combustible, minimum 0.100 inch thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

2.10 In finished spaces, wall plates shall be thermoset plastic (phenolic, urea), non-combustible, mar proof, minimum 0.100 inch thick, with color matching metal screws; "smooth" styling. Plates shall match color of devices.

2.11 Coverplates for telephone and other communication system outlets shall be a blank coverplate or shall have a 0.625 inch diameter grommeted opening unless indicated otherwise on the drawings or in the respective communication system specifications. Color and material of plates shall match plates provided for other wiring devices (for 302 stainless steel, 0.625 inch I.D. grommet in 0.875 inch hole, strap mounted; two gang equal to P & S Sierra #S 788N; single gang #S 754N; for high impact thermoplastic, 0.375 inch hole single gang, strap mounted equal to P & S Sierra #RP 12 I where P line ivory wallplates are used).

PART 3 - EXECUTION

3.1 Locate devices as shown on the drawings, coordinate exact location with other trades, to avoid interference. Check for potential interference from door swings, cabinets, heating equipment and other wall mounted devices.

3.2 Clean debris from outlet boxes.

3.3 Install receptacles with grounding pole on bottom.

3.4 Verify each receptacle device is energized and test each device for proper polarity.

3.5 Adjust devices and wall plates to be flush and level.

END OF SECTION

26 28 13 FUSES

PART 1 - GENERAL

1.1 Safety switches and other fusible protective devices provided under this contract shall be complete with fuses properly sized to protect the feeders and equipment served.

1.2 Fuses shall not be shipped installed in switches in electrical equipment nor shall they be shipped to the job site until the equipment is ready to be energized. Fuses shall be of the same manufacturer to retain selectivity as designed.

PART 2 - PRODUCTS

2.1 Manufacturers shall be Bussmann, Mersen, Littelfuse or Edison.

2.2 Fuses shall be current limiting with 200,000 amperes interrupting capacity, all shall be UL labeled.

2.3 Fuses, 601 ampere to 6,000 ampere (bolt type dimensions) shall be UL Class "L" fuses. The size and type is indicated on drawings; Bussmann HI CAP time delay fuse KRP C shall be used.

2.4 Fuses with ampere ratings 1 ampere to 600 ampere (standard dimensions) shall be UL Class RK 1. The size and type is indicated on drawings. Bussmann LOW PEAK Time Delay fuse LPN RK (250 volts) or LPS RK (600 volts).

2.5 Where Bussmann specific fuse types are indicated above or on the drawings, acceptable fuses by cross reference of manufacturers are:

Voltage UL Class	Ratings	Bussmann	Mersen	Littel Fuse	Edison
L	600 V	HI CAP KRP C	AMP TRAP A4BQ( )	POWR-PRO KLPC	LCL
RK 1		Low Peak	AMP TRAP II	POWR-PRO	
	250V	LPN RK	A2D ( ) R	LLN-RK	LEN-RK
	600V	LPS RK	A6D ( ) R	LLS-RK	LES-RK
J (Time Delay)	600V	LPJ ( )	AJT ( )	JTD ( )	JDL ( )

PART 3 - EXECUTION

3.1 Place a fuse identification label showing type and size inside door of each switch. Use fuse reducers where fuse gaps are larger than fuse dimension.

3.2 Verify fuse types before installation for proper application by voltage and ampere ratings; fuses protecting motors shall not exceed 150 percent of motor nameplate amps. (Applies to fuses in sizes 600 amps and below.)

3.3 Furnish the Owner with a minimum of 25 percent of quantity of each size installed, but not less than one complete set of three spare fuses for each size of fuse furnished. Provide a typewritten bill of material and install in plastic cover to inside of cabinet door.

END OF SECTION

26 28 16 DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 Provide disconnect switches, fused and non-fused, where indicated on the drawings and in the specifications, and where required by the NEC.

PART 2 - PRODUCTS

2.1 Disconnect switches shall be listed by Underwriter's Laboratories and shall be manufactured by Square D, Siemens, G.E. or Eaton. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

2.2 Switches shall be Heavy-Duty Type, NEMA 1 enclosures, non-fused except where fuses are specified or required to protect wiring from overload; provide raintight NEMA 3R type enclosures for outdoor applications unless otherwise noted.

2.3 Disconnect switches shall be quick-make, quick-break, externally operated with door interlocked with operating handle. Provide solid neutral and ground bars where indicated or where required by the application.

2.4 Disconnect switches shall have multiple padlock provisions in the off position.

2.5 The fuse holders shall be designed for Class "R" rejection type fuses.

2.6 Refer to "Identification for Electrical Systems" Section for nameplate requirements.

PART 3 - EXECUTION

3.1 Mount top of wall mounted disconnect switch 6 ft.-0 inches above floor where space permits.

3.2 Coordinate location of disconnect switches to avoid interference with other equipment and trades and allow access for safe operation.

END OF SECTION

26 29 13 MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 Schedules on the drawings list motors with disconnect and starter requirements and associated controls. Motor starters and disconnects shall be furnished under this Contract except where specifically shown or specified to be furnished by other trades. Motor starters and disconnects shall be manufactured and rated in accordance with NEMA, UL and IEEE standards. IEC RATED CONTACTORS AND OVERLOADS ARE NOT ACCEPTABLE.

1.2 Refer to "Disconnect Switches" Section for switch requirements.

1.3 All motor starters shall be rated for the available fault current at the point of application.

PART 2 - PRODUCTS

2.1 Manufacturer Allen Bradley, whose catalog numbers are used herein as a standard, or equivalent by Square D Type S (Class 8536), G.E. Series CR306, Eaton Class AN16 or Siemens "U.S. Series". All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.

2.2 Where new motor starters and disconnect switches are to be installed in existing motor control centers they shall match existing units.

2.3 Magnetic starters shall be line voltage suitable for the service listed on the drawings. Each starter shall have one extra auxiliary contact for future control purposes, a 3-leg melting alloy thermal overload relay on a single block, a manual reset mechanism, a 120-volt control coil, Bulletin 509. Contractor shall have the option of installing Bulletin 512 combination starters in place of separately mounted switches and starters. Disconnects shall be fused type unless otherwise specifically indicated or required by NEC.

2.4 A HAND-OFF-AUTO selector switch shall be mounted in the face of each starter enclosure. The selector switch shall be so wired that when it is in the HAND or AUTO position, all SAFETY controls are wired in series with the selector switch; all CONTROL DEVICES shall be wired in the AUTO position only.

2.5 Each starter enclosure shall have a suitable 120-volt secondary control transformer fused separately on each phase of the primary and secondary, and grounded on the secondary.

2.6 Each starter shall have a red LED pilot light mounted in the face of the starter enclosure. The LED shall be wired so it will be on when the motor is energized.

2.7 Magnetic starters shall be furnished for motors, one horsepower and greater or any 3-phase motor, unless indicated otherwise on plan.

2.8 Manual starters with thermal overload protection shall be furnished for fractional horsepower, single phase motors unless otherwise noted and shall be Bulletin 600 with a pilot light, flush mounted in finished areas.

2.9 Two speed starters shall be separate winding (two winding); Bulletin 715 with adjustable time delay on high to low speed. Contractor shall verify that starter being provided is proper for motor being furnished.

2.10 Unless otherwise noted or required by Code, safety switches shall be Heavy Duty Type, NEMA 1 enclosures, fused except where fuses are specified or required to protect wiring from overload. Switches shall be quick make, quick break, externally operated with door interlocked with operating

handle and padlock provisions in OFF position. Provide solid neutral and ground bars where required. Switches located outside shall be raintight NEMA 3R, unless otherwise noted.

PART 3 - EXECUTION

3.1 Check full load ampere and service factor rating of each motor after installed and furnish the proper size overload heater elements to protect the motor.

3.2 Those portions of interlock and control wiring which are required but not prewired, shall be done in the field.

3.3 Motor starters and disconnect switches shall be conveniently accessible; all NEC minimum clearances from walls, pipes, ducts, equipment, etc., shall be maintained. Locate as inconspicuously as possible in finished spaces.

3.4 Refer to "Identification for Electrical Systems" section for nameplate requirements.

3.5 Place label in each motor starter door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage / phase, OL type and OL size.

END OF SECTION

26 32 13 B NATURAL GAS-ENGINE DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 Total system consists of an engine driven generator and controls, automatic transfer switch, fuel system and piping, exhaust system with muffler and piping and cooling sub system and emergency power distribution. Refer to the drawings for capacity and electrical characteristics.

1.2 Ratings shown on drawings are for continuous standby service.

1.3 The package generator set shall be UL 2200 listed and labeled. If the generators are not UL 2200 listed in order to meet NEC 700 and 701 selective coordination requirements then it will be the contractor and manufacturers responsibility to obtain a UL field listing for the complete generator system.

Equipment either internal or external to comply with the certification shall be furnished, installed, tested and warranted to provide a complete operational system.

80 – 1800 KW	40 CFR Part 1054

Emission standards equipment to be rated for minimum 10 years in standby operation (operating up to 500 hours per year). Warranties to cover all components and labor whose failure would increase the engine's emission of any pollutant maintenance of the equipment to maintain the emissions warranty shall be included under the contract and signified by a signed agreement by the generator maintenance company performing the service.

PART 2 - PRODUCTS

2.1 Unit shall be of standard design by Kohler, Caterpillar, MTU Onsite Energy, Cummins or Generac. Custom manufactured or one-of-a-kind units, and units by other suppliers will not be approved.

2.2 Engine shall be multiple cylinder, 4 cycle, water cooled, natural gas fueled developing not less than KW indicated at a governed speed of 1800 rpm at an elevation of 1000 ft. above sea level at 100 degrees inlet air temperature. Engine shall have electronic isochronous governor to maintain speed regulation within 0.5 percent from no load to full load. Lubrication shall be pressure type. Engine to be provided with air cleaner, lubrication oil filter, fuel filter with electric fuel shut off valve, radio interference suppression, flexible fuel line connection, acid resistant battery box, battery cables, crank, stainless steel flexible exhaust line connection, silencer and 120 V or 208 V - 1 phase, AC engine block heater for water cooled models. Starting shall be accomplished by 12 or 24 volt system.

2.3 Generator shall be direct connected to engine crank shaft, with automatic voltage regulation. Generator to include auxiliary field and voltage stabilizer to ensure good motor starting characteristics. It shall be self-ventilated of drip proof construction with Class H insulation and meeting NEMA, AIEE and ASA standards for temperature rise and vibro mounted with less than 10 percent vibration transfer from unit to floor. Power factor 0.80.

A. Capability to assume load with transient limits per ISO 8528-5:2018 Class G2.

Frequency Deviation (Percent) for 100%Load Increase	< -10%
Frequency Deviation (Percent) for 100 % Load Decrease	<+12%
Frequency Recovery Time (Seconds) for 100 % Load Change	<5 Sec
Voltage Deviation (Percent) for 100 % Load Increase	<-20%
Voltage Deviation (Percent) for 100 % Load Decrease	<+25%

Voltage Recovery Time (Seconds) for 100 %Load Change	<6 Sec
Frequency Droop (Percent)	<-3%

B. Generator features shall include:

a. Voltage regulation plus or minus/percent.
b. Steady state frequency regulation plus or minus 0.5 percent.
c. Capability to assume loads with transient limits per ISO 8528-5:2013 listed above.
d. Insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method.

2.4 Control panel shall be vibration mounted on generator frame. It shall include start/stop switch, overcranking protection designed to open cranking circuit after approximately 45 to 60 seconds cranking, cranking reset button, alarm contact, automatic battery charging. Ammeter, voltmeter, selector switch, water temperature gauge, oil pressure gauge, running time meter and all alarms required by NFPA-110.

A. Provide summary alarm dry contacts (2 NO) that close upon any generator alarm condition for interface with fire alarm panel and/or other building system panel(s).

B. Include supervision w/start signal from ATS and alarm for loss of integrity. Start engine from command or from loss of signal integrity.

2.5 Surface mounted remote annunciator(s) of all alarms required by NFPA 110; locate the annunciator(s) as shown on the floor plans. Include red and green lamps indicating position of each automatic transfer switch.

A. Provide summary alarm dry contacts (2 NO) that close upon any generator alarm condition for interface with fire alarm panel and/or other building system panel(s).

2.6 Main breaker shall be generator mounted, molded case, thermal magnetic trip type for load circuit breaking and line protection. Rated and sized for approximately 125 percent full capacity of generator output. For generator size with output greater than 400 A, provide isolated bus bar on each phase and neutral for landing the lugs on the outgoing feeder; oversize termination box on generator to meet NEC wire bending radius and space for bus bars and cable terminations.

2.7 Provide the following engine accessories:

A. Twelve-volt or 24 volt starting battery and charger with an adjustable trickle charge rate and a high charge rate. Battery charger shall include a DC ammeter and voltmeter, AC circuit breaker and a DC fuse, AC power failure relay, low DC voltage alarm relay and 0 24 hour equalizing timer; LaMarche in NEMA 1 enclosure or equal by Charles Industries Model AE. The battery shall not be discharged through the battery charger. Provide corrosion resistant battery box.

1. A gas regulator (rated for 1 lb. delivery gas pressure) with pressure gauge on inlet, fuel shut off solenoid valve and fuel strainer shall be furnished with the unit. (Connections by Plumbing Division 22 Contractor include manual shut off valve, dirt leg and union.)

2. Stainless steel flexible exhaust connection; critical type exhaust muffler equal to Maxim M 51 or equal by Burgess, EM Products, Inc., Universal “ENS”, York “Y4” or Cowl.

3. Integrally mounted cooling system radiator and belt driven fan with guard; provide overflow reservoir.

4. Red mushroom engine stop button with protection lift cover and sign “Emergency Engine Stop”, surge gang box mounting. A remote engine stop button will be located in the Garage building at the main electrical service.

5. Provide a factory installed weather protective type sound attenuating (75 db at 7 meters horizontal and 5 feet above grade) housing around generator for outdoor installation. Standard features associated with housing shall be as follows:

   a. Hinged and removable side and rear panels for easy access to generator set.
   b. Vertical outlet hoods with 90 degree angles and baffles to redirect air and reduce noise; UL 94 HF1 listed acoustic insulation for flame resistant standards.
   c. Louvers on both the generator air intake and radiator air discharge ends for cooling; prevent rain and snow entry.
   d. Lockable latches on each removable or hinged panel; all parts of latches and hinges and mounting hardware shall be stainless steel.
   e. Rugged steel construction; galvanized steel or aluminum; painted with accepted manufacturer’s standard painting process. Skid mounted. Color selected by Architect/Engineer.
   f. Battery rack.
   g. Insulated critical rated silencer with tail pipe and rain cap; mount silencer inside generator enclosure.
   h. Rodent barriers and insect screens over all openings including louvered openings.

6. The engine generator system shall pick up full load in less than 10 seconds.

7. The supplier shall furnish a certified full load test certificate verifying that the generator has been tested prior to delivery and found to be in satisfactory working condition under test loads.

PART 3 - EXECUTION

3.1 Installation

A. Mount engine generator on concrete base with adjustable spring type vibration dampeners or factory installed isolators between engine and skid. Bolt firmly to foundation. Concrete pad shall be 8 inches thick, 4000 pound test concrete with #4 rebar 12 inches on center each way in center of pour. Pad shall extend 6 inches past enclosure on all four sides, with chamfered edges. Form sleeves in pad for conduit entry and place conduits prior to pouring. Pad shall be 3 inches above and 5 inches into finished grade. Over excavate and provide a 12-inch thick compacted pea gravel sub-base below pad.

B. Make external connections to generator and engine thru flexible connectors.

C. Connect auxiliary systems all in accordance with manufacturer's specific instructions for automatic and manual operation.

D. Furnish and install all control wiring and interlocking between the engine generator, generator control panel, automatic transfer switch, remote annunciator, damper control, etc.

   1. Control wiring between the generator and transfer equipment shall be independent of other wiring and achieve a 2-hour fire rating per NEC 700. And generator control shall monitor control circuit for integrity.

E. Install remote engine stop button at entry to room or outside enclosure. Connect to engine controls for shutdown.

F. Fill radiator and cooling system with 50/50 solution of ethylene glycol additives and water for freeze protection and engine protection as recommended by manufacturer. Freeze protection down to –32 degrees to -40 degrees F for Ohio and neighboring states.

G. Neutral shall not be bonded to generator. Bonding of neutral and ground is accomplished in main switchgear. Provide signs at service entrance location and at grounding location per NEC 702.7. Provide labeling if bonding is modified in field from the manufacturer standard.

H. Submit test report based on NFPA 110.

I. Include in the demonstration / training the documentation requirements to comply with the permit-by-rule requirements of the State of Ohio.

J. Provide sign at the service entrance indicating type and location of on-site power sources per NEC 702.7.

K. Provide loadbank, associated cables, metering and operation assistance for factory start-up and commissioning functional operation testing for up to full load test.

3.2 Testing and Demonstration

A. The supplier shall furnish a certified full-load test certificate verifying that the generator has been tested prior to delivery and found to be in satisfactory working condition under test loads.

B. Adjust, test and demonstrate proper operation of the system. Test shall demonstrate automatic operation, transfer, quick start and a minimum of 2 hour endurance under not less than 50 percent load and with not less than 2 hours at full load. Provide temporary wiring to existing or new loads to demonstrate and test or provide a temporary resistance load bank for the test.

C. Run a single step load test - Engine generator system shall pick up full load (100%) in less than 10 seconds. All generators to be paralleled and on-line in less than 10 seconds.

D. Run step loading per either ISO 8528-5 Class G2 according to the BMEP of unit stated in paragraph above.

E. Run an AHJ acceptance test for the emergency power system. Furnish to AHJ – evidence of protype test, certified analysis of torsional vibration capability, letter of compliance to NFPA 110 standard for unit as installed and manufacturer's certificate of rated load test. Record transfer time and loads for steps and time required.

3.3 The installation will be commissioned by an outside commissioning agent. Any commissioning/operational deficiencies discovered shall be corrected at no additional cost. This shall include any additional site trips to correct deficiencies and retest. <u>All costs for additional load bank testing for equipment failure(s) as a result of the installation by the electrical contractor shall be paid for by the electrical contractor.</u>

3.4 Personnel training should cover systems operation, record keeping and periodic maintenance. Operator is to be familiar with all power system components, alarm conditions, operation and maintenance procedures. Also shall be knowledgeable of system fuel storage and delivery, starting batteries, engine coolant heaters and airflow both in and out.

3.5 All exit lighting, emergency lighting and emergency power wiring shall be run in a conduit system separate from the normal building wiring system.

3.6 Permit

A. Obtain the information and forms to submit for “Permit-by-“Rule” exception of OAC 3745 to the State of Ohio for installation and operation of the standby generator. Coordinate with the owner for their testing and fuel reporting operations. Request shall be submitted sufficiently in advance of generator start-up to receive approval of the permit.

3.7 Provide training with manufacturer’s instructions for Owner to adjust, operate and maintain engine and record keeping requirements to comply with EPA.

END OF SECTION

26 36 23 A AUTOMATIC TRANSFER SWITCHES (ASCO SERIES 7000)

PART 1 - GENERAL

1.1 Furnish and install electrically operated automatic switch to transfer loads to standby system upon failure of main source of electricity. Unit shall be complete with accessories in NEMA 1 enclosure or mounted in switchboard as shown on the drawings. Automatic transfer switch shall conform to the requirements of NEMA Standard ICS2 447, NFPA 110, NEC and UL 1008 and shall be UL listed.

1.2 Switch shall be electrically operated, mechanically held type with a mechanical interlock to prevent both sides closing simultaneously, except for closed-transition transfer switch(es).

PART 2 - PRODUCTS

2.1 Manufacturer ASCO Bulletin 7000 Series or equivalent by Russelectric with the following features:

A. Voltage and ampere ratings as indicated on the drawings; complete with terminating lugs. ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current and overcurrent protection shown on the drawings and per table:

Withstand and Close-On Ratings for all Transfer Switches

Frame	Switch Rating (Amps)		Current Limiting Fuses				Specific Breaker			Time Based				Short Time Ratings[3] (sec)							
														480V Max.				600V Max.			
	Transfer Switches	Bypass Switches	480V Max.	600V Max.	Max Size, A	Class	240V Max.	480V Max.	600V Max.	Time (sec)	240V Max.	480V Max.	600V Max.	.1	.13	.3	.5	.1	.13	.3	.5
D	30	-	100kA	-	60	J	22kA	22kA	10kA	0.025	10kA	10kA	10kA	-				-			
D	70, 100	-	35kA	35kA	200	RK1	42kA	22kA	10kA	0.025	10kA	10kA	10kA	-				-			
			200kA	35kA	200	J															
D	150	-	35kA	35kA	200	RK1	65kA	25kA	10kA	0.025	10kA	10kA	10kA	-				-			
			200kA	35kA	200	J															
D	200	-	200kA	-	200	J	65kA	25kA	-	0.025	10kA	10kA	-	-				-			
D	230	-	100kA	-	300	J	65kA	25kA	-	0.025	10kA	10kA	-	-				-			
E	260, 400	-	200kA	-	600	J	65kA	42kA	35kA	0.05	35kA	35kA	22kA	-				-			
J	150[7], 200[7], 230[7], 260,400	150[7], 200[7], 230[7], 260, 400	200kA	200kA	600	J	50kA	50kA	42kA	0.05	65kA	42kA[5]	35kA	-				-			
J	600	600	200kA	200kA	800	L	50kA	50kA	42kA	0.05	65kA	42kA[5]	35kA	-				-			
H	600	600	200kA	200kA	800	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA		-		36kA		-	
P	600	600	200kA	200kA	800	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA		30kA		36kA		-	
P	800	800-1200	200kA	200kA	1600	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA		30kA		36kA		-	
H	800-1200	800-1200	200kA	200kA	1600	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA		-		36kA		-	
Q	600-1600	600-1600	200kA	200kA	2000	L	65kA	65kA	65kA	0.05	65kA	65kA	65kA	50kA				50kA			
S	800-1200	800-1200	200kA	200kA	2500	L	100kA	100kA	65kA	0.05	100kA	100kA	65kA	65kA				65kA			
G	1000 - 1200	1000 - 1200	200kA	200kA	2000	L	85kA	85kA	85kA	0.05	85kA	85kA	85kA	-				-			
G	1600-1200[4]	-	200kA	200kA	2500	L	85kA[4]	85kA[4]	85kA[4]	0.05	85kA[4]	85kA[4]	85kA[4]	-				-			
G	1600-2000	1600-2000	200kA	200kA	3000	L	125kA[8]	125kA[8]	100kA	0.05	100kA	100kA	100kA	42kA		-		42kA		-	
S	1600-2000	1600-2000	200kA	200kA	2500	L	100kA	100kA	85kA	0.05	100kA	100kA	85kA	85kA		65kA		85kA		65kA	

G	2600-3000	2600-3000	200kA	200kA	4000	L	100kA	100kA	100kA	0.05	100kA	100kA	100kA	42kA	-	42kA[6]	-
G	3200	-	200kA	-	4000	L	100kA	100kA	-	0.05	100kA	100kA	-	-		-	
G	4000	4000	200kA	200kA	5000	L	100kA	100kA	100kA	0.05	100kA	100kA	100kA	85kA	65kA	65kA	
U	2600-4000	2600-4000	200kA	200kA	5000	L	125kA[9]	125kA[9]	125kA[9]	0.06	125kA[9]	125kA[9]	125kA[9]	100kA		100kA	

Notes:

1. All WCR values indicated are tested in accordance with the requirements of UL 1008. See ASCO Pub 1128 for more WCR information.
2. Application requirements may permit higher WCR for certain switch sizes.
3. Short Time ratings are provided for applications involving circuit breakers that utilize trip delay settings for system selective coordination.
4. Optional front connected service (Accy 40MY and 40NY) limits 1600 and 2000A G Frame switches.
5. Switches utilizing overlapping neutral (code "C") have 35kA, 0.050 Sec time based rating at 480V Max
6. 3000A ratings are for Transfer Switch configurations only.
7. J150, 200, 230 Amp available in 7ACTS, 7ADTS, 7ASLS, & All 7000 Bypass Switches only
8. Rating shown is for Bypass switches only, Transfer Switch rating is 100kA.
9. Service Entrance Switches rating is 100kA.

B. Three pole solid neutral.

C. Service entrance rated with molded case circuit breaker on normal source. Breaker rated above 1000 amperes shall have adjustable long time, short time, instantaneous and GF settings. Copper neutral and ground busses with removable disconnect link.

D. Conventional two-position, open-transition transfer switching

E. Closed-transition transfer switching with back-out timers and relay protection.

1. The Automatic Closed-Transition Transfer Switch shall have main contacts that overlap, permitting the transfer of electrical loads without power interruption. The switch shall transfer in a make-before-break mode if both sources are within acceptable parameters. Control logic shall continuously monitor source conditions and automatically determine whether the load transfer should be open (conventional non-overlap mode or closed transition).

2. Closed-Transition Transfer shall be achieved passively within 5 electrical degrees and in less than 100 milliseconds. Active control of the engine generator should not be required. Should the selected manufacturer require additional control wire runs between the ATS and engine generator set governor they shall be included in the Contract. Provide backout timers and protective relaying (consult the local utility on protective relay requirements).

3. Failure to synchronize annunciation and extended parallel time protection shall be built-in to the closed transition controls to prevent abnormal operation.

F. In phase monitor (ASCO Group 5, accessory 27) or adjustable timed off position (Russellelectric RMTD Delayed dwell transfer).

G. Provide heavy duty metering instruments designed especially for switchboard use. Mount all such instruments on a front hinged door for access to internal wiring connections. All wiring passing across the door hinge shall be extra flexible type. The following shall be included:

1. One digital type ammeter and 4 position selector switch; 3-metering current transformers on loadside of the ATS.

2. One digital type voltmeter and 7 position selector switch wired to indicate phase to neutral and phase to phase voltage; connect to load side.

Note: in lieu of above items 1) and 2), an integrated monitoring system similar to Square D Power Logic Model PM5563 with integral digital display and RS-485 data communications port is acceptable; equal by Eaton Model DPM 4000, Siemens Model 9340 or G.E. Model 5350.

H. Provide a transient voltage surge suppressor (TVSS) on the load side of the automatic transfer switch; refer to Section 26 43 13; connect thru a fused disconnect switch to the load terminals of the ATS; conductors to the TVSS must not exceed 18 inches in length. Fuse size and type as recommended by the TVSS manufacturer shall be shown on the ATS shop drawing submittal.

I. Remote status and test panel consisting of two position indicating lamps and one remote test switch for each automatic transfer switch; install in NEMA 3R enclosure and mount adjacent to the emergency generator or incorporate in the emergency generator control panel.

2.2 The following accessories shall be included:

A. Engine Start Time Delay - Field adjustable 0 to 6 second time delay to prevent false tripping on momentary power drops; set at 3 seconds.

B. Transfer to emergency time delay; field adjustable 0 – 60 minutes; set at zero.

C. Adjustable time delay (quantity two) 0 to 60 minutes to retransfer to normal, to permit voltage stabilization before selected source assumes load; power failure mode set at 15 minutes and test mode set at 30 minutes. Instantaneous retransfer to normal in event of emergency source failure.

D. Field adjustable 0 to 60 minute unloaded running time delay for engine cool down; set at 5 minutes.

E. Undervoltage differential protection on normal source set for 85 percent (adjustable) dropout and 90 percent (adjustable) pickup; monitor all three phases line to line. Overvoltage (adjustable) dropout set at 115 percent and pickup at 102 percent. Under frequency (adjustable) set for 70 percent dropout and 90 percent pickup. Over frequency (adjustable) set at 105 percent and pickup at 110 percent.

F. Auxiliary contacts to initiate cranking of emergency generator - one normally open and one normally closed; and circuitry designed to prevent "dry cranking".

G. Test switch mounted on enclosure face; simulates normal source failure; momentary contact type. Provide guard. Also terminal provisions for a remote contact which opens to signal the ATS to transfer to emergency.

H. Independent three phase voltage (adjustable), and frequency sensing of the emergency source; set to drop out at 80 percent and pickup at 90 percent for voltage and pickup at 90 percent and drop out at 70 percent for frequency. Overvoltage to pick up at 120 percent and dropout at 110 percent. Over frequency to pick-up at 110 percent and dropout at 105 percent of rated frequency.

I. Programmable microprocessor controller with keypad and LCD display; shall include engine exerciser capability.

J. Position indicating lamps (normal and emergency) on face of panel; Red LED for long life.

K. Source available lights (normal and emergency) on face of panel; Red LED for long life.

L. Summary single pole, double throw contact indicating ATS is connected to emergency source and the normal source has failed. Connect to building control system for indication or to generator remote annunciator.

2.3 Additional accessories shall include:

A. Field adjustable 0 to 5 minute timer delay on all switches. Adjustable timer to permit step loading of the generator.

B. Terminals for remote contacts which open to signal ATS to transfer to emergency. And terminals for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Jumper if not used for control schemes, leave for future use.

C. Auxiliary contacts for “switch position”, “emergency source present” and “normal source present”. Two sets for each.

D. Communications Module – full duplex RS485 interface for serial communication and Ethernet between ATS controllers.

E. Internal buffer to provide backup power to controller and power manager for communications. External 24 VDC source, (ASCO feature IPS and accessory 1G).

2.4 Provide 5-year extended warranty (parts and labor). Provide the certificate directly to the Owner accompanied by a letter of transmittal. Provide a copy to the Engineer with shop drawings.

PART 3 - EXECUTION

3.1 Switches shall be mounted in distribution panels where so noted. Independently enclosed units shall be wall mounted using appropriate brackets or inserts with top at 6 feet 0 inches above floor.. Mount and anchor floor set units on a 4-inch high concrete pad furnished by this Contractor.

3.2 Connect automatic transfer switch to initiate cranking of the emergency generator and to provide remote indication and remote testing where specified or indicated on drawings. Include installation of all wire and conduit associated with each automatic transfer switch.

3.3 Connect controls to generator and protective relaying for closed transition transfer operation.

3.4 Demonstrate operation of transfer switch in bypass, normal and emergency modes.

3.5 Arc Flash Evaluation Studies are provided by the distribution switchgear manufacturer. The Contractor shall apply the appropriate labels to the automatic transfer switches.

END OF SECTION

26 41 00 A FACILITY LIGHTNING PROTECTION SYSTEM (ALTERNATE 02)

PART 1 - GENERAL

1.1 Work includes a complete system of lightning protection, consisting of points, connectors, conductors and driven ground rods. System shall be provided for the total building, including all exhaust fans, mechanical equipment, pipe stacks, etc., protruding from the roof.

1.2 Materials, design and installation shall comply with Underwriters Laboratories, Inc. Master Label requirements and NFPA 780. A Master Label is required.

PART 2 - PRODUCTS

2.1 Manufacturers - Maxwell Lightning Protection Co., Dayton, Ohio; Thompson Co., St. Paul, Minnesota; Independent Protection Co., Goshen, Indiana; Harger Lightning Protection, Inc., ERICO, Thermoweld or Union Lightning Protection Co.

2.2 All material shall be copper. All materials shall be UL labeled. Where roof flashing or parapet coping caps are aluminum or materials not compatible with copper, the air terminals and conductors used on the roof shall be of compatible materials.

2.3 Minimum 0.50 inch x 18 inch solid copper blunt points (complying with OSHA requirements) on building and penthouse roofs, high points and corners.

2.4 Copper connecting and down conductors; approved copperclad steel grounding rods.

2.5 Approved connectors and devices.

2.6 Submit drawings for approval before delivering material and beginning work. Drawings shall show point number, size, location, conductor route and size, grounding and details of connectors and devices to be incorporated into the system; submit catalog data for each item of material. Furnish master label certificate upon completion. Provide as built shop drawings.

PART 3 - EXECUTION

3.1 Install 1 inch schedule 40 PVC and conceal down conductors in structure during initial stages of construction in all new work. The Architect shall be consulted and give final approval for location of down conductors.

3.2 Secure all points to structure by approved methods; coordinate with Architect. The lightning protection system shall be adhered directly to the roof surface with the adhesive recommended by the roofing supplier. Roofing contractor must supply and install all wear pads, stripping, battens, heat welded strips or pavers, whichever may or may not occur due to their choice of roofing manufacturer. Coordinate with roofing contractor to ensure a complete, coordinated system is provided.

3.3 Bond all metal bodies within 6 feet of the conductors with approved fittings and conductors.

3.4 Connect to the water system where the water supply enters the building.

3.5 Install surge arresters on the electric service(s) when not included elsewhere in the specs. Refer to Section 26 43 13 - Surge Protective Devices (SPD) for type and manufacturers.

3.6 Provide necessary common grounds between the lightning protection system and the electric and telephone service entrance wires, TV and radio antenna grounds.

3.7 Work shall be performed by an experienced and accredited installer of the manufacturer whose materials are approved and listed.

3.8 All connections to driven ground rods shall be by exotheromic welding process by ERICO, "Cadweld" or Thermoweld.

3.9 Connections to driven ground rods or other earth electrodes shall be a minimum of three feet from the foundation wall or beyond the roof drip line, whichever is greater and at least one foot below grade.

END OF SECTION

26 43 13 SURGE PROTECTIVE DEVICES (SPD'S) FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 This specification describes the mechanical and electrical requirements for a low voltage Surge Protective Device (SPD); refer to Article 285 of the NEC. The SPD shall be suitable for application in category environments as described.

1.2 The SPD with integral disconnect switch and overcurrent protection shall be UL Listed for parallel connection to the electrical system. Delete if connected to a dedicated operable OCP device.

1.3 Refer to the following specification sections for factory installation of the SPD in equipment:

26 24 13	Distribution Switchboard (Below 600 Volts)
26 24 17	Panelboard with Surge Protective Device
26 36 23	Automatic Transfer Switches

1.4 Submit the following for approval:

A. All related shop drawings, product data, manufacturer's installation instructions and maintenance manuals.

B. Dimensional drawing of each SPD type indicating mounting arrangements.

C. Single line diagram indicating all field connection requirements, conductor and overcurrent sizes, recommended conduit type, alarm contacts, etc.

D. Maximum Surge Current Rating: Provide test reports demonstrating that the SPD is capable of surviving the specified maximum surge current rating. The rating shall be provided on a per mode basis. Reports shall clearly show that the tests have been performed on a COMPLETE SPD including all necessary fusing, thermal disconnects, integral disconnects, monitoring systems, etc.

E. Minimum repetitive surge current ratings: Test reports from a third-party testing organization will demonstrate that a COMPLETE SPD has been tested to specified ratings. A complete device will include all necessary fusing, thermal disconnects, integral disconnects, monitoring systems, etc.

F. Provide name of the nationally recognized independent testing laboratory that performed tests verifying that the COMPLETE SPD can survive the published surge current rating on a per mode and per phase basis and at maximum surge current level the fuses survive without blowing when the manufacturer recommended disconnect and overcurrent protection are installed in same test and circuit.

G. UL documented Voltage Protection Ratings (VPR) for all modes. (L-L, L-N, L-G, N-G)

H. Short Circuit Current Rating (SCCR).

I. Maximum Continuous Operating Voltage Rating (MCOV).

J. I-nominal (I-n).

K. Type listing.

1.5 Manufacturers Qualifications: Firms regularly engaged in the manufacture of SPD products for specified category and whose products have been in satisfactory service for not less than 5 years.

1.6 UL compliance and labeling: Listed per latest edition of UL 1449 Fourth Edition and latest editions of UL 1283 and UL 1414 for Electromagnetic Interference Filters, where applicable.

1.7 SPD shall be independently laboratory tested.

1.8 NEC compliance: Comply with NEC as applicable to construction and Article 285 for installation. The mounting position of the SPD shall permit a short lead length.

1.9 In accordance with NEC Article 285, the SPD shall be clearly marked with the short circuit current rating. The SCCR rating shall meet or exceed the rating of the equipment to which it will be applied. Providing additional fusing to meet this requirement shall not impact the maximum surge current rating or the minimum repetitive surge current rating. Test reports furnished from third party testing organizations shall verify this.

1.10 The SPD shall be warranted for unconditional failure replacement for a minimum of 10 years inclusive of all labor to restore the device to functionality. The first 5 years of this warranty will include the field labor required to remove/replace/or repair the failed SPD. Submit Warranty with shop drawings.

1.11 The SPD MOVs will be individually fused to provide full system redundancy and provide a short circuit current rating of 200kAIC. The fusing system will also allow the full maximum surge current rating to pass through without fuse operation.

1.12 By ANSI/IEEE C62.45 definition, “Category C3 Combination Wave” is 20 KV 1.2 microsecond open circuit voltage, 10 kA 8/20 microsecond short circuit current. Where category C3 is referenced in this specification, it shall mean the same.

1.13 The overcurrent protection/disconnect device shall have a short circuit current rating SCCR greater than that available on the electrical distribution system.

PART 2 - PRODUCTS

2.1 The SPD for main service entrance rated 800 A and above and unit substations shall be located inside the main section of the switchboard and have:

A. SPD shall be UL labeled as Type 1 – verified through certification at UL.com.

B. A surge current capacity of 240,000 amps minimum total per phase (8/20 microsecond surge current pulse) and rated for category C3; minimum 120 kA L-G, 120 kA L-N, 120 kA N-G.

C. SPD shall be UL labeled with 20 kA I-nominal I-n for compliance to UL96A Lightning Protection Master Label and NFPA 780.

D. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1200V	700V
480Y/277	1200V	1200V	2000V	1200V

(Mode VPRs verifiable at UL.com. Numerically lower is allowed/preferred/ old-style suppressed voltage ratings (SVRs) shall not be submitted, nor evaluated due to outdated less-strenuous testing).

E. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

F. The SPD shall have a minimum repetitive surge current rating of 5,000 ANSI/IEEE C62.41 Category C3 impulses. Manufacturers may propose alternative maximum surge current ratings provided that this requirement is met.

G. All modes of protection L-L, L-N, L-G and N-G.

H. When a suppression filter system is supplied, it shall comply with UL 1283. Typical noise attenuation shall be:

-34 dB at 100 kHz; -51 dB at 1 MHz; -54 dB at 10 MHz; -48 dB at 100 MHz.

I. Approved manufacturers and models, subject to compliance with requirements, are:

MAIN SERVICE		
	120/208V	277/480V
Eaton	SPD250-208Y3M	SPD260-480Y3M
Joslyn (T&B)	JSP240-3Y208B	JSP240-3Y480B
Current Tech (T&B)	CGP120-120/208-3GY	CGP120-277/480-3GY
ASCO	520120YP25ACCLIX	520277YP25ACCLIX
Square D	SSP02EMA24D	SSP04EMA24D

2.2 The SPD for panelboards, load side of automatic transfer switch and for main service rated 400A. to 600A. where indicated on the drawings shall have:

A. SPD shall be labeled as type 2 – verified through certification on UL.com.

B. A surge current capacity of 120,000 amps minimum total per phase (8 x 20 microsecond waveform) and rated for category C3; 60 kA L-G; 60 kA L-N; 60 kA N-G.

C. SPD shall be UL labeled with 20 kA I-nominal I-n.

D. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1000V	800V
480Y/277	1200V	1200V	1800V	1200V

E. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

F. The SPD shall have a minimum repetitive surge current rating of 5,000 ANSI/IEEE C62.41 Category C3 impulses. Manufacturers may propose alternative maximum surge current ratings provided that this requirement is met.

G. All modes of protection L-L, L-N, L-G and N-G.

H. UL 1283 high frequency extended range tracking filter. Typical noise attenuation shall be:

-34 dB at 100 kHz; -51 dB at 1 MHz; -54 dB at 10 MHz; -48 dB at 100 MHz.

I. Approved manufacturers and models, subject to compliance with requirements are:

PANELBOARDS AND LOAD SIDE OF ATS		
	120/208 V	277/480 V
ASCO	520120YP13ACCLIX	520277YP13ACCLIX
Eaton	SPD 120-208Y3M	SPD 120-480Y3M
Joslyn (T&B)	JSP 120-3Y208B	JSP 120-3Y480B
Current Tech (T&B)	CGP60-120/208-3GY	CGP60-277/480-3GY
Square D	SSP02EMA12D	SSP04EMA12P

2.3 For panelboards with integral surge suppression and filter system where indicated on the drawings, refer to Section 26 24 17 Panelboard with Surge Protective Device.

2.4 The SPD shall be compatible with the electrical system, voltage, current and distribution configuration; for single phase connected electrical system provide the appropriate SPD.

2.5 The SPD shall use only solid state clamping components to limit the surge voltage.

2.6 The SPD shall use LED indicators, which provide indication of proper suppressor operation and of suppression-failure; provide means for assuring lamps are operable. Include optically isolated N/C drop contacts for remote monitoring.

2.7 A means of mechanical safety disconnect shall be provided with a symmetrical fault current commensurate with the installation location. This disconnect shall be used for isolating the SPD from the electrical service for repair/testing without taking the whole panelboard, switchboard, or ATS out of service.

PART 3 - EXECUTION

3.1 For switchgear and switchboard applications, connect the SPD to the main bus. Provide a 3-pole molded case breaker or fusible switch with overcurrent protection integral with the SPD enclosure to serve as a means of mechanical disconnect. Fuse sizes and type shall be provided by the SPD manufacturer. Provide 3 spare fuses for each SPD. Note: The SPD and overcurrent/disconnect device shall have a short circuit current rating SCCR greater than that available on the electrical system.

3.2 All conductors shall be copper and sized per the manufacturer's recommendations. The conductors are to be as short and straight as practically possible and shall not exceed 18 inches in length and shall be installed in PVC conduit (as local jurisdiction allows) where raceway is required. The input conductors are to be twisted together to reduce the SPD system inductance.

3.3 The SPD shall be installed following the SPD manufacturer's recommended practices and in compliance with all applicable codes.

3.4 A SPD will not withstand an overvoltage condition. Disconnect each SPD before using testing equipment on the system such as meggars and high voltage test equipment.

3.5 Before energizing the SPD and before installation of the SPD shall be considered complete, the Contractor shall verify the integrity of the ground system to which the SPD is connected including grounding of all service entrance neutrals and neutrals of all separately derived systems as required by the NEC.

END OF SECTION

26 51 19 LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 Refer to schedule on the drawings for information on luminaires, drivers and manufacturers. Luminaires of manufacturers other than those listed, if offered, shall be on a substitute basis and so listed as a substitute with the bid. (Refer to Section 26 05 01, para. 2.4 B.)

1.2 The catalog numbers listed on the luminaire schedule do not necessarily have complete prefix and suffix designations for placing the luminaire order. The Contractor shall verify these numbers (with associated notes on the luminaire schedule) and include in their bid the necessary accessories, trims, mounting hardware, etc. to achieve a coordinated installation with ceiling types indicated on the architectural drawings and in specifications. The Contractor shall provide any hardware indicated by notes on the fixture schedule.

1.3 Luminaires, drivers and individual components shall bear UL label.

1.4 Where luminaires are installed in fire rated ceilings the following methods may be utilized: fire rated light covers, fire boxes or custom-built boxes. Detail of method shall be submitted.

1.5 Submittals

A. Detailed cut sheets for all LED luminaire complete assemblies shall be submitted for approval with shop drawings. Identify pertinent information such as the manufacturer, frequency operation, reset thermal protection, etc. Also, submit emergency battery driver cut sheets for review. Shop drawings will be rejected if required information is not submitted.

B. Submittals shall include dimensions, ratings, performance data and components of each luminaire. Where indicated on schedule, submit two (2) color chips illustrating luminaire finish color.

PART 2 - PRODUCTS

2.1 LED Luminaire Components

A. LED Luminaire

1. LED luminaire shall be rated for an installation/ambient temperature from -40 degrees C to +40 degrees C.
2. LED luminaire shall be modular in design (when applicable per the basis of design) with the ability to replace drivers, light engines, arrays, optics, reflectors, etc., without having to replace the entire luminaire.
3. The heat sink shall be easily accessible for maintenance or cleaning to maintain the overall thermal performance of the luminaire within specifications. The light engine and driver shall be easily accessible for maintenance.
4. LED luminaire (type V distribution) shall have an even distribution of luminous intensity within the 0 degree to 90 degree zone. Luminous intensity at any angle within this zone shall not differ from the mean luminous intensity for the entire 0 degree to 90 degree by more than 10 percent.
5. Exterior LED luminaire shall be full cutoff or fully shielded as defined by IESNA-RP-8.
6. LED luminaire shall come standard with the ability for full dimming. When luminaire is to be powered by generator for emergency operation the luminaire is to be UL 924 listed.
7. LED Luminaire shall have a minimum of 5 year warranty.
8. Solid State Lighting (LED) – UL 1598.

B. LED/LED Module

1. LED/LED Module(s) shall be manufactured by:
   a. Nichia
   b. Cree
   c. Achriche
   d. Phillips
   e. Osram/Sylvania
   f. Approved Equal (By Engineers approval)
2. LEDs shall be of the highest production quality.
3. LED/LED Module shall be rated for 50,000 hours of life at 70 percent output (L70) and shall have been tested in accordance with IESNA LM-79, LM-80, and TM-21.
4. LED/LED Module manufacturers shall adhere to LED package manufacturer guidelines, certification programs, and test procedures for thermal management.
5. LED/LED Module(s) shall be rated for a minimum luminous efficacy of 90 Lumens per Watt (lm/W).
6. Color consistency NEMA SSL-3.
7. LED/LED module shall have a minimum CRI of 80. High CRI where noted shall be minimum 90 (sample R1 – R8) with sample R9 minimum 80.
8. LED/LED Module(s) shall have one of the following designated CCTs (Correlated Color Temperature) per ANSI C78.377-2008 and all within the 7-step chromaticity quadrangles as defined below:
   a. 2700 K
   b. 3000 K
   c. 3500 K
   d. 4000 K
   e. 5000 K
9. LED/LED Modules shall originate from a common manufactured batch source.
10. Contractor shall provide 5 percent of each module specified as spare in original sealed packaging and transport to the Building (and put in storage) as directed by the Owner.

C. LED Driver

1. The driver shall have 50,000 hrs. of anticipated/rated life. Minimum efficiency of 85 percent at full load conditions.
2. UL 8750 approved.
3. Driver shall meet UL Class 2 for use in dry or damp location.
4. FCC rule title 47CFR Part 15, Class A minimum compliant.
5. Driver shall have inherent short-circuit protection, self-limited, overload protected. (UL 1449)
6. Driver shall have a Class A sound rating.
7. Driver rated for 100 to 277 volt input. Power factor .90 or higher.
8. All drivers shall provide full LED dimming range (or as indicated on the drawings). The drivers in every LED fixture shall have the capability to be dimmable, whether indicated to be dimmed or not on the drawings. When luminaire is to be powered by generator for emergency operation the driver is to be UL 924 listed.
9. Driver shall have a minimum of 5 year warranty.
10. Contractor shall provide 5 percent of each driver specified as spare in original sealed packaging and transport to the building (and put in storage) as directed by the Owner.

D. The complete LED luminaire assembly shall be of the latest and highest efficacy design available.

2.2 Battery Powered Exit and Emergency Lighting Luminaires

A. Each unit shall consist of a sealed, maintenance free nickel-cadmium battery,which delivers 90 minutes capacity to emergency lamps. LEDs, drivers, automatic controls and connection to the lighting circuit ahead of all switches. Operation shall be such that the battery is maintained

constantly charged under normal conditions; upon a loss of normal power, the light shall be switched on and the operating current obtained from the battery.

B. Units shall be UL labeled. Refer to drawings for mounting, capacity and manufacturer.

C. Fasten battery operated exit and emergency lighting units to wall or ceiling using factory-furnished bracket and make rear concealed electrical connection.

D. Electric source shall be from unswitched active lighting circuits only, to ensure that battery will be charged from an active circuit.

E. Test switch provides manual activation of 30 second diagnostic testing for visual inspection. Where noted for self-diagnostic testing, fixture to operate 30 seconds every 30 days and 90 minutes once annually. Performing diagnostics of LED light source, AC to DC transfers, charging and battery condition.

2.3 LED AC/Emergency Driver Units – Battery Type

A. Emergency lighting shall be UL listed and labeled and shall be provided by using standard LED luminaires equipped with a self-contained mounted battery-inverter power pack. Furnish and install with each designated luminaire a power pack unit to operate luminaire assembly upon loss of normal power. Initial output rating shall be minimum 50% lumen output (or as coordinated with manufacturer). Warranty shall be 5 years from date of acceptance.

B. Emergency operation shall be fully automatic with the power pack unit capable of driving the selected luminaire at rated output for a minimum of 90 minutes with a lumen depreciation no greater than 50 percent.

C. Power pack units shall include a sealed maintenance-free nickel cadmium battery, a solid-state charger, an automatic transfer circuit, a low voltage battery disconnect circuit to prevent battery damage from deep discharge and a high frequency inverter. An accessible test switch and AC “on” pilot light shall be installed in the fixture and require no field wiring.

D. The power pack’s inverter electronics and battery driver shall, without requiring modification, be compatible with standard driver and luminaire assembly supplied and shall not affect normal luminaire operation and shall be used with either a switched or unswitched luminaire. Connect to an unswitched hot leg for either base for charging/loss of power.

E. Unit to include test switch, status indicator and rechargeable battery. Charger to have two charge rates and automatically recharges after battery discharge.

F. Provide remote test switch for installation where indicated on plan or where routine testing would be difficult due to luminaire location or accessibility. This option shall consist of a pushbutton test switch and AC “on” pilot light mounted on a white nylon single gang switch plate.

G. Self diagnostics testing, where noted, operates 30 seconds every 30 days and 90 minutes once annually. Performing diagnostics of LED light source, AC to DC transfers, charging and battery condition.

H. LED type inverter units shall be Dual Lite or equal by Chloride, Siltron, Power Sentry, Bodine, Side Lite or IOTA Engineering Company.

2.4 Luminaires with Integral Controls

A. Stairwell Luminaires, Control Features

1. LED modules multi-voltage drivers, 90 minute nickel-cadmium battery pack (EL) includes inverter charger, test switch and charging indicator lamp.

2. Dual technology occupancy sensor. Controls line voltage to operate luminaire. Detects motion via electromagnetic waves or PIR, so sensor can be used behind luminaire lenses. 120/277 VAC operation with 20 feet radius of operation. Time delay from 30 seconds to 20 minutes, sensitivity adjustable, dims down to 10%.

B. Luminaires with Integrated Automation Sensing Devices

1. Provide integral sensing device(s) mounted on luminaire(s) as noted on the drawings or other specification sections.

2. Coordinate installation and wiring per manufacturer requirements. Provide interface and any related programming to other systems as denoted on the drawings / specifications. Functionality for all integral luminaire sensing devices to be fully tested and confirmed by Division 26 Contractor. Provide test results as a submittal to the Engineer.

PART 3 - EXECUTION

3.1 Luminaire Hanging and Supporting

A. Support each surface mounted or suspended luminaire in a minimum of two locations. In addition, where luminaires are in a continuous row, they shall be fastened together on each end in two places. For suspended luminaires provide pendant length required to suspend luminaire at indicated height.

B. Recessed luminaires shall be supported at all four corners. Additionally, securely fasten each luminaire to the ceiling framing member by mechanical means such as bolts, screws, rivets or approved clips; install a minimum of one on each of the four sides of luminaire. This Contractor shall coordinate luminaire locations and luminaire weight with the trade installing the ceiling system to ensure adequate hangers are installed to support the weight of the ceiling plus twice the weight of each luminaire.

C. Surface or flush LED luminaires in ceilings of the suspended lay in type shall be installed so that the long dimension of the luminaire is supported on the main support members of the ceiling system.

D. In addition, all recessed LED luminaires for lay in ceilings shall be equipped with at least two galvanized steel safety support wires, or chains, attached from the luminaire housing to the structure independent of the ceiling system; hangers supporting ceiling system shall not be used.

E. Install safety cable / chain support for gymnasium luminaires per manufacturer’s direction. Coordinate structural connection with Architect.

F. Do not support light fixtures directly from light weight roof decks. Provide supplemental angle iron support as required. Do not connect to bottom cord of roof joist without supplemental angle iron ties to the upper cord of joist.

G. For wall mounted exterior luminaires include gasketed cast junction box.

H. Wire battery powered emergency fixtures to circuit which is constantly on. For LEDs in fixtures which are switched the charging / sensing circuit shall be extended from ahead of room switch.

3.2 Alignment and Cleaning

A. Luminaires shall be mounted straight, level and true to the building lines. Warped or damaged luminaires shall be replaced or repaired to the satisfaction of the Architect and Owner.

B. Immediately preceding the final inspection, this Contractor shall thoroughly clean all luminaires of dust, dirt, grease, fingermarks, etc. All LED luminaires shall be operating at the time of Owner's acceptance.

C. Coordinate location of luminaires carefully with the Architectural reflected ceiling plan. Verify that no surface mounted luminaire interferes with door swings.

1. Coordinate locations of luminaires with mechanical ducts, sprinkler pipes/heads, smoke alarms and fire alarm devices prior to rough-in to prevent conflicts.
2. Where reflected ceiling plans indicate a larger quantity of luminaires than that shown on the electrical drawings for a particular space, the reflected ceiling plan shall be followed for that space.

D. Adjust all adjustable fixtures to the satisfaction of the Engineer and the Owner.

3.3 Turn over required spare LED components, identified in above specification sections, to Owner.

3.4 Exit and Emergency Lighting Installation

A. Exit lighting and emergency lighting system wiring shall be run in conduit system which is completely independent of normal wiring systems.

B. Equipment to transfer power from a normal source to an emergency source are to be listed and labeled for load transfer.

C. All circuits shall have dedicated neutral conductor.

D. Adjust the coverage of related occupancy sensors and dimming control.

E. Test system operation for full 90 minutes witnessed by the AHJ. Provide report of required corrections, if any.

F. Batteries shall carry a five (5) year warranty.

3.5 Specialty LED Luminaires

END OF SECTION

26 56 19 LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 Work includes a complete system of exterior lighting including luminaires, LED modules, LED lamps, poles, bases, conduit, conductors, fusing, control devices, etc. as shown on drawings. Include all excavation, backfill, concrete bases and concrete encasement of underground conduits.

1.2 The catalog numbers listed on the schedule do not necessarily have complete prefix and suffix designations for placing the luminaire order. The Contractor shall verify these numbers and include in their bid the necessary accessories, trim, mounting hardware, etc. to achieve a coordinated installation with the design/layout as indicated on the electrical drawings and in specifications. The Contractor shall provide any hardware indicated by notes on the fixture schedule.

1.3 Luminaires, LED drivers and individual components shall bear UL label. All LED drivers shall be high efficiency and high power factor (HPF).

PART 2 - PRODUCTS

2.1 Refer to notes and data on the drawings for fixture details.

2.2 The pole manufacturer shall provide a factory installed internal impact type vibration damper in each pole where indicated on the drawings or when the pole is 25 ft. or greater in length.

2.3 Each pole shall be sized to accommodate EPA of complete luminaire / pole assembly for wind velocity of 90 mph and gusting wind equivalent of 117 mph. Electrical Contractor shall touch up all paint on site after installation.

PART 3 - EXECUTION

3.1 Concrete bases for standards shall be round above finish grade, chamfered corners and rubbed finish. Furnish anchor bolts as recommended by the manufacturer. Concrete bases shall be poured-in-place at the job site; steel reinforced concrete, minimum 3500 lb. test.

3.2 Provide a surge arrester behind the handhole in pole base of each lighting standard exceeding 15 ft. in height and connect to each phase conductor and 0.625 inches diameter by 10 ft. long copper clad driven ground rod providing a good grounding path. Connect the equipment grounding conductor to this grounding terminal. A separate ground rod is required for each lighting standard exceeding 15 ft. in height. Surge arresters shall be Thomas Research Products BSPS series or Hubbell FSP3 series. Install per NEC Article 242 Overvoltage Protection.

3.3 Provide Buss "KTK" fuses in HEB waterproof in-line holder ahead of the LED driver in each "hot" leg; locate behind handhole in pole base, unless otherwise noted.

3.4 Note these special installation procedures – never install a pole without the intended luminaire in place. Poles are designed to carry a load, and a pole cannot be installed before the luminaire is mounted because of the potential for damaging the pole from unwanted vibrations.

3.5 Mount standards truly vertical. Shim and grout under fixture base to level standards; visible shims will not be permitted. Provide anchor bolt covers.

3.6 Splicing shall be made with listed and approved, waterproof splicing kits and shall be located in base of poles behind handhole.

3.7 Locate handhole on side of pole which will be least visible to normal sight lines.

3.8 Provide receptacle on side of pole as per drawing details.

3.9 Install a green wire ground throughout the underground wiring system, and bond to all standards.

3.10 Measure illumination levels to verify conformance to Performance Requirements.

3.11 Take measurements during night sky, without moon or with heavy overcast clouds effectively obscuring moon.

3.12 Luminaires with integral occupancy and photosensors shall have operation verified.

3.13 Coordinate installation of pole mounted security cameras or other sensing devices per manufacturer requirements. Provide additional conduit and wiring as detailed on the drawings.

END OF SECTION

27 05 01 BASIC COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 Refer to Section 26 05 01 Basic Electrical Requirements which are hereby made part of Division 27 - Communications.

1.2 Special Note

A. All provisions of the Bidding Requirements, General Conditions and Supplementary Conditions, including Division 00 and Division 01, apply to work specified in this Division.
B. Take special care in reviewing and including required responsibilities as detailed in the Commissioning Specification Sections 01 91 13 and 27 08 00. Instruct respective subcontractors to do the same.

1.3 Alternates

A. Alternate___-___._____ ADD ALTERNATE

The base bid work does not include _____
_____.

Each bidder is requested to state the addition in cost to provide all Communications work for _____.

B. Alternate___-___._____ DEDUCT ALTERNATE

The base bid work includes _____
_____.

Each bidder is requested to state the deduction in cost to delete from the Communications work for _____.

C. Alternate___-___._____ CHANGE IN SYSTEM, EQUIPMENT, ETC.

The base bid work includes_____
_____.

Each bidder is requested to state the addition or deduction in cost to provide _____
_____ in lieu of the base bid _____
_____.

D. Alternate___-___._____ ALTERNATE MANUFACTURER OR MATERIAL

The base bid work includes _____
_____ manufactured by _____.

Each bidder is requested to state the addition or deduction in cost to provide, in lieu of the base bid manufacturers,_____
_____ by_____
_____.

1. _____.
2. _____.
3. _____.

E. Refer to the description of Alternates in Division 01, Section _____ which affect the Division 27 work.

1.4 Permits and Regulations

A. Include payment of all permit and inspection fees applicable to the Division 27 work. Furnish for the Owner certificates of approval from the governing inspection agencies, as a condition for final payment.

B. Work must conform to the National Electrical Code, National Electrical Safety Code and other applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawings and specifications shall govern. Install no work contrary to minimum legal standards.

C. All electrical work shall be inspected and approved by the local jurisdictional authority.

D. All electrical work shall be inspected and approved by the Ohio Division of Industrial Compliance who will issue the inspection certificate.

E. Upon completion of work, the Contractor shall furnish to the consulting State Architect the certificate of inspection and approval before final payment on contract will be allowed.

1.5 Inspection of Site

A. Inspect the project site \ and the \ premises of the existing building. Conditions shall be compared with information shown on the drawings. Report immediately to the Architect \ Construction Manager any significant discrepancies which may be discovered. After the contract is signed, no allowance will be made for failure to have made a thorough inspection.

1.6 Drawings and Specifications

A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible.

1. The word "provide", as used, shall mean "furnish and install".
2. The phrase “shall support” shall mean that no additional time, material or labor is required to have the specified referenced feature/function/capability fully operational.
3. If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect / Construction Manager for approval before proceeding with the work.

B. Make all necessary field measurements to ensure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.

C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect / Construction Manager for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having wireways and fittings fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.

1. Where there are quantity discrepancies of equipment shown on drawings and/or specifications, the Contractor shall provide the greater quantity.

D. The Architect / Construction Manager shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of protecting and concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

E. Equipment, ductwork, piping and communications wiring shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Guarding. Caution other trades to comply with this stipulation.

F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's / Construction Manager's decision shall be final in regard to the arrangement of conduit, etc., where conflict arises.

G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.

H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect / Construction Manager. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect / Construction Manager.

1.7 Asbestos Materials

A. Abatement, removal or encapsulation of existing materials containing asbestos is not included in the Division 27 Contract. Necessary work of this nature will be arranged by the Owner / Construction Manager to be done outside of this construction and remodeling project by a company regularly engaged in asbestos abatement. Such work will be scheduled and performed in advance of work in the construction and remodeling project.

B. If, in the performance of the work, materials are observed which are suspected to contain asbestos, the Contractor shall immediately inform the Architect / Construction Manager who in turn will notify the Owner. Work that would expose workers to the inhalation of asbestos particles shall be terminated. Work may be resumed only after a determination has been made and unsafe materials have been removed or encapsulated and the area declared safe.

1.8 Coordination Drawings

A. The Division 23 Contractor shall prepare and be responsible for 0.25inch scale electronic coordination drawings. These drawings shall be produced using a computer aided drafting software of a mutually agreed upon format with the Division 21, 22, 23, 26, 27 and 28 Contractors. Each Contractor shall prepare their own electronic drawings, using common backgrounds obtained from the Architect and Structural Engineer. The Division 23 Contractor shall be responsible for consolidating (merging) the drawings into combined coordination drawings, and lead the conflict resolution process, with all contractors working together to obtain finished coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

B. Review by the Engineer is cursory. It is the Contractors responsibilities to ensure that all work is coordinated, including fit above ceilings and that specified ceiling heights are maintained.

1.9 Inspection

A. All work shall be subject to inspection of Federal, State and local agencies as may be appropriate, and of the Architect and Engineer.

B. Obtain final inspection certificates and turn over to the Owner.

1.10 Record Drawings

A. Maintain a separate set of field prints of the contract documents and show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work and within 90 days of system acceptance, these drawings shall be turned over to the Architect / Construction Manager. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.11 Operating and Maintenance Manuals

A. Assemble electronic copies each of operating and maintenance manuals for the Communications work.

B. All “approved” shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list, and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, prepare and include a chart listing all items of equipment which are furnished under this contract, indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Name and address of a qualified service agency.

C. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instructions are not available.

D. Original purchase order number, date of purchase, name, address, and phone number of the vendor warranty information.

E. Copy of required test reports.

F. These shall be assembled into three-ring loose leaf binders or other appropriate binding. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Engineer and / Construction Manager for review. Upon approval, manuals shall be turned over to the Owner.

G. O&M Manuals shall contain the following information at a minimum:

1. Copies of all approved shop drawings with the Engineer’s stamp.
2. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

3. Communications drawings updated with final as-built information. This shall be in the form of a complete set of Communications drawings with as-built information indicated in colored pen based upon actual field conditions.
4. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

1.12 Final Inspection and Punch List

A. As the time of work completion approaches, survey and inspect Division 27 work and develop a punch list to confirm that it is complete and finished. Then notify the Architect and Construction Manager and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.

B. Requests to the Architect, Engineer or Construction Manager for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

C. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.13 Warranty

A. Warrant all workmanship, equipment and material entering into this contract for a period of one (1) year **or the period of time as per specific specification section,** from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. The use of equipment for temporary communication systems is not the start of the warranty period.

B. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems are placed in operation. These items include, but are not limited to replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.

C. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.

D. Provisions of this warranty shall be considered supplementary to warranty provisions under Division 01 General Conditions.

1.14 Software Support Agreement

A. Provide a software support agreement (SSA) with the project for each system with user software, that covers the entirety of the systems including all end devices, servers, etc. as part of the completed system for a period of not less than 1 year. Agreement shall cover software upgrades, system patches and firmware releases and all labor/material to implement at no additional cost to the owner.

B. The SSA shall commence at the completion of the project after final inspection, system demonstration and system traininig.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Materials and equipment furnished shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electronic equipment provided under this scope of work shall be of a make/model that is currently in production at the time of installation.

C. No equipment shall be provided under the scope of this work that has been listed by the manufacturer for End Of Life/End Of Support.

D. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL labeled items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

2.2 Reference Standards

A. Where standards (NFPA, NEC, EIA/TIA, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the Authority Having Jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

B. Cyber Security – NIST, UL 2900-1, ISO/IEC 27001

2.3 Equipment Selection

A. The selection of materials and equipment to be furnished shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
2. Where the words "or approved equal" appear after a manufacturer's name, specific approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.

B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.

C. Within ten (10) days after award of contract, the names of Subcontractors and manufacturers of the major items of equipment which are proposed shall be submitted to the Architect / Construction Manager for approval. Refer to the list of equipment below.

D. Before bidding equipment, and again in the preparation of shop drawings, verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC clearances are met.

E. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in this contract.

2.4 Shop Drawings

A. Electronic copies of shop drawings and descriptive information of equipment and materials shall be furnished. Submit to the Architect and/or Engineer for review as stated in the General Conditions and Supplementary Conditions. These shall be submitted as soon as practicable and before equipment is installed and before special equipment is manufactured Submittal information shall clearly identify the manufacturer, specific model number, approval labels, performance data, pump curves, electrical characteristics, features, specified options and additional information sufficient to evidence compliance with the contract documents. Product catalogs, brochures, etc. submitted without project specific items marked as being submitted for review will be rejected and returned without review. Shop drawings for equipment, fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. If compliance with the above criteria is not provided shop drawings will be subject to rejection and returned without review. Samples shall be submitted when requested or as specified here with-in.

B. The review of shop drawings by the Architect or Engineer shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.

C. Electronic format – Shop drawings may be submitted in electronic format utilizing PDF files. The submittal shall be organized by specification section and contain all required information within a PDF document for each specification section. The submittal shall be organized as follows:

1. Primary zip file contains a PDF of master transmittal cover page indicating the project name, submitting contractor, contact information and a list of all the sections with titles being submitted. This primary file shall also contain each of the individual PDF files for the individual sections being submitted.
2. Sub PDF file for each specification section organized as follows:
    a. First page - Cover page indicating the project name, submitting contractor, contact information, space for Engineer’s stamp.
    b. Page(s) for contractor qualifications and project certifications.
    c. Page(s) for Bill of Materials (BOM) list including part numbers, quantities and references to specification section paragraphs for each part.
    d. Page(s) for manufacturer’s data sheets.
    e. Page(s)/Drawing(s) for system diagrams, riser diagrams, block diagrams, etc.
    f. Drawing(s) for floor plans showing equipment locations.

D. Refer to individual system specifications for submittal requirements. At a minimum, shop drawings shall contain the following information:

1. A complete list of materials with model and part numbers and reference to the Part 2 specification paragraph number.
2. Shop drawings including manufacturer’s product and cable data sheets specific to the project. Data sheets shall indicate exact model numbers and options specific to the project.
3. Floor plans showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.
4. Job specific schematic and point to point wiring diagrams showing all devices, number and size of wires, etc.
5. Contractor qualifications and/or Manufacturer’s Certifications where specifically specified.

6. System software information, where applicable showing features, version, hardware requirements, and any other information required to ascertain conformance with specifications.

E. Equipment that does not fully comply with the specifications and which has not had this information presented in the shop drawing phase and approved, will be removed and replaced with specification compliant equipment at the contractor's expense.

F. Cyber Security

1. Submit for approval the Cyber Security Hardening checklist that will be used for each system with associated network connected devices and software.

G. Any shop drawings that do not contain the minimum required information outlined herein and as specified elsewhere shall be considered incomplete and will not be reviewed. It is the contractor's responsibility to fully read and understand all requirements for submittals for each section and to carefully and completely adhere to all requirements.

2.5 Computer Workstations

A. All computer workstations provided under this contract shall utilize the same manufacturers chipsets, hardware and peripherals. All processors shall be either Intel or AMD. It shall also be required to provide the same manufacturer for monitors, keyboards, mice, video cards, etc. Refer to specs in each section for specific requirements such as processor speed and base memory.

B. All computer workstations provided under this contract shall be equipped with fully licensed, automated, active anti-virus software. Approved anti-virus software packages shall be as produced by Norton, McAfee or Symantec.

C. All computer workstations and software packages provided under this contract shall provide required hardware, software and drivers to be fully compatible with Appletalk protocol are communications standards.

D. All computer workstations provided under this contract shall be provided with two (2) IEEE 1394 (Firewire) 6 pin ports and with an 802.11 n/ac and wireless Ethernet NIC.

2.6 Network Enabled Devices with username/password

A. All devices which include a username/password shall be set by the contractor during construction as directed by the owner.

B. Devices shall not be left at default unless specifically directed by the owner.

C. Turn over a spreadsheet with all devices including device description, MAC address, IP address (if static) username and password.

PART 3 - EXECUTION

3.1 Testing

A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.

B. As each electrically operated system is energized, it shall be tested for function.

C. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.

D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Refer to specific sections for required testing of the various systems. Submit four (4) copies of reports indicating results.

E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.

F. Instruments required for tests shall be furnished by the Contractor.

3.2 Equipment Cleaning

A. No fixed item of active AV/Network/Security electronic equipment shall be installed in any areas where active construction is generating significant amounts of dust/debris (drywall finishing, concrete sanding, wall painting, etc.). It shall be the responsibility of this contractor to fully coordinate the activity of the general trades contractors with regards to floor/wall/ceiling finishing work to assure that active AV/Network/Security equipment is not exposed to or damaged by the materials and debris generated by these and similar activities.

B. No fixed item of passive AV/Network/Security equipment (such as cabling, faceplates, jacks, etc.) shall be installed in any areas prior to substantial completion of floor/wall/ceiling installation and finishing where the installation of such equipment will expose it to damage or defacement from those general trades activities. This contractor shall be fully responsible to fully protect/isolate any installed equipment from damage/defacements from the installation of or application of materials and finishes associated with the General Trades Work.

C. This contractor shall be responsible for fully protecting all equipment and providing final cleaning to restore equipment to its original pre-installation condition prior to project completion and turn-over to owner.

D. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

3.3 Operation and Adjustment of Equipment

A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents; verifying phase rotation; setting breakers, ground fault and other relays, controllers, meters and timers; and adjusting all operating equipment.

3.4 Operating Demonstration and Instructions

A. Set the various systems into operation and demonstrate to the Owner and Architect / Engineer / Construction Manager that the systems function properly and that the requirements of the Contract are fulfilled.

B. Provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.

C. O & M Manuals shall be submitted, reviewed and approved prior to scheduling of demonstrations.

D. A minimum of 24 hours shall be allowed for instruction to personnel selected by the Owner. Instructions shall include not less than the following:

1. Show location of items of equipment and their purpose.
2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that each is understood by personnel.
4. Manufacturer's representatives for the various special and communication systems shall give separate instructions.

E. A minimum of 48 hours continuous trouble-free operating time shall be acceptable to prove that the systems function properly.

F. Note that additional time for training, operating time, etc. may be required per other specification sections and shall be included. This section only establishes minimum requirements.

END OF SECTION

27 05 02 AGREEMENT AND WAIVER FOR USE OF ELECTRONIC FILES

PART 1 - GENERAL

1.1 The Engineer, at his sole discretion and without obligation, makes graphic portions of the contract documents available for use by the contractor in electronic format. These electronic files are proprietary, and remain the Engineer's Instruments of Service and shall be for use solely with respect to this project, as provided in the Standard Form of Agreement between Owner/Architect and Engineer.

1.2 Electronic files shall be released only after bids have been received for the project and contracts have been signed with the contractors.

1.3 The contractor shall acknowledge receipt of electronic files in the requested format for this project. The electronic files are provided as a convenience to the User, for use in preparing shop drawings and/or coordination drawings related to the construction of only the project identified in the Agreement. The electronic files and the information contained within are the property of the Engineer and/or the Architect and/or the Owner, and may not be reproduced or used in any format except in conjunction with the project identified in the Agreement.

1.4 The User acknowledges that the information provided in the electronic files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The User acknowledges that neither the Engineer, the Architect, the Consultants, the Client or the Owner make any warrant or representation that the information contained in the electronic files reflect the Contract Documents in their entirety. The User assumes full responsibility in the use of the electronic files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

1.5 The User acknowledges that the receipt of electronic files in no way relieves the User from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

1.6 Electronic files are available in the AutoCAD .DWG or Revit model format for a cost as indicated in the Agreement and Waiver Form. Providing the documents in the .DXF format will be an additional charge per sheet as indicated in the Agreement and Waiver Form. Charges are for the Engineer's time to prepare the documents in the format stated. They are available through the Engineer's office on a C.O.D. basis only. A sample of the format will be provided by the Engineer upon request by the contractor, for the purpose of testing the compatibility of the format to contractor's systems.

1.7 Projects developed using AutoCAD MEP will have all drawings converted to the AutoCAD format, when requested to be DWG or DXF format.

1.8 Project models will be furnished without views.

1.9 The electronic files shall be stripped of the Project's name and address, the Architect's / and / Engineer's / and / any consultant's name and address, and any professional licenses indicated on the contract documents, (and all dimensions, verbiage, and statistical information). Use of these electronic files is solely at the contractor's risk, and shall in no way alter the contractor's Contract for Construction.

1.10 The User agrees to indemnify, hold harmless and defend the Engineer, the Architect, the Consultants, the Owner, the Client and any of their agents from any litigation resulting from the use of (by any means of reproduction or electronic media) these files. The Engineer makes no representation regarding fitness for any particular purpose, or suitability for use with any software

or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Engineer's or its consultant's computer software or hardware defects or errors; the Engineer's or its consultant's electronic or disk transmittal of data, information or documents; or the Engineer's or its consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Engineer's consultants to the Engineer.

1.11 The contractor waives all claims against the Engineer, its employees, officers and consultants for any and all damages, losses, or expenses the contractor incurs from such defects or errors in the electronic files. Furthermore, the contractor shall indemnify, defend, and hold harmless the Engineer, and its consultants together with their respective employees and officers, harmless from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications, resulting from the contractor's distribution of electronic files to other contractors, persons, or entities.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 Attached "Agreement" shall be submitted with accompanying payment to the Engineer prior to delivery of electronic files.

END OF SECTION

27 05 02A
ELECTRONIC FILES HEAPY RELEASE FORM TO CONTRACTORS

Project: Greater Dayton RTA – Paratransit Bus Garage and Wash
701 Longworth Street
Dayton, OH

Owner: Montgomery County, Ohio

Heapy Engineering Project Number: 2023-07202

Heapy Engineering Project Manager: Don Timmer

The Provider, named below, will furnish the Recipient, named below, certain documents prepared by the Provider or its sub consultants in an electronic format. These documents are hereinafter **collectively** referred to as "Electronic Files". The Electronic Files are instruments of the Provider services performed solely for the Owner's benefit and to be used solely for this Project. The Provider does not represent that the information contained in the Electronic Files are suitable for use on any other project or for any other purpose. If the Electronic Files are used for any other project or purpose without the Provider's specific written permission, the risk of such use shall be assumed solely by the Recipient or other user.

Prior to the use of the Electronic Files the Provider and the Recipient agree to the following terms and conditions:

1. The Provider and Recipient fully understand that the data contained in these electronic files are part of the Provider’s Instruments of Service. The Provider shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

2. The Recipient confirms their request to the Provider for Electronic Files for the Project listed above, which the Recipient understands are to be provided only in accordance with, and conditioned upon, the terms and conditions of this Agreement and Waiver for Use of Electronic Files.

3. The Provider agrees that the Recipient may use the Electronic Files for the sole purpose of preparing shop drawings and/or coordination drawings for the above Project only. Any Electronic Files provided are strictly for the use of the Recipient in regard to the Project named above, and shall not be utilized for any other purpose or provided by the Recipient to any entity other than its subcontractors for the Project named above.

4. The Recipient acknowledges that the furnishing of Electronic Files in no way relieves the Recipient from the responsibility of shop drawings or other schedules as set forth in the Contract between the Contractor and the Owner.

5. The Recipient acknowledges:

    a. That the Electronic Files do not contain all of the information of the Bid Documents or Contract Documents for the construction of the Project above.

b. That information in the Bid Documents or Contract Documents may be revised or modified in the future.

c. The Provider does not have, and will not have, any duty or obligation to advise or give notice to the Recipient of any such revisions or modifications.

d. That the Recipient agrees that its use of the Electronic Files is at the Recipient's sole risk of liability, and that the Recipient shall make no claim or demand of any kind against the Provider arising out of Recipient's receipt or use of the Electronic Files.

6. The Provider makes no representation or warranty of any kind, express or implied, with respect to the Electronic Files and specifically makes no warranty that the Electronic Files shall be merchantable or fit for any particular purpose, or accurate or complete. Furthermore, any description of said Electronic Files shall not be deemed to create an implied or express warranty that such Electronic Files shall conform to said description.

7. Due to the unsecured nature of the Electronic Files and the inability of the Provider or the Recipient to establish controls over their use, the Provider assumes no responsibility for any consequences arising out of the use of the data. It is the sole responsibility of the Recipient to check the validity of all information contained within the Electronic Files. The Recipient shall at all times refer to the Construction Documents of the project during all phases of the project. The Recipient shall assume all risks and liabilities resulting from the use of this data, and the Recipient agree(s) to waive any and all claims and liability against the Provider and its sub consultants resulting in any way from the use of the Electronic Files.

8. Electronic Files are provided strictly as a courtesy by the Provider solely for the convenience of the Recipient, and are not part of the Bid Documents or Contract Documents for the Project. The Electronic Files do not replace or supplement the paper copies of any drawings, specifications, or other documents included in the Contract Documents for use on the project.

   a. The Recipient assumes full responsibility in the use of Electronic Files, including the responsibility to see that all manual modifications, addenda, bulletins, clarifications and Change Orders to the drawings executed as a part of the Contract Documents have been incorporated.

9. As stated herein, the possibility exists that the Electronic Files provided may differ from the Bid Documents or Contract Documents for construction of the Project. The Provider shall not be responsible, nor be held responsible, for differences between Electronic Files, the Bid Documents, and Contract Documents. The Bid Documents or Contract Documents for the Project may be modified by the Provider at any time, either before or after construction begins. The Provider has no responsibility, either before or after any such modification, to determine or to advise the Recipient whether any such modification causes Electronic Files provided to the Recipient to be out of date, inconsistent with the Bid Documents or Contract Documents, or otherwise unsuitable or unfit for use in any way.

10. The Recipient assumes all risk and liability for any losses, damages, claims, or expenses (including defense and attorney fees) resulting from its receipt, use, or possession of Electronic Files furnished by the Provider. The Provider makes no representation, warranty or guarantee that the Electronic Files:

    a. Are suitable for any other usage or purpose.

    b. Have any particular durability.

    c. Will not damage or impair the Recipient's computer or software.

d. Contain no errors or mechanical flaws or other discrepancies that may render them unsuitable for the purpose intended by the Recipient.

11. Recipient agrees to indemnify, defend and hold harmless the Provider, agents, employees, and the Owner from, and against, any and all claims, suits, losses, damages or costs, of any kind or nature, including attorney's fees, arising from or by reason of the Recipient's use of Electronic Files provided by the Provider, and such defense and indemnification obligation duties shall survive any use under this Agreement and Waiver for Use of Electronic Files.

12. The Recipient agrees that the Provider shall have no responsibility whatsoever for problems of any nature arising from transmitting and storing electronic files at a Recipient requested FTP or project management site or the conversion of the Electronic Files by the Recipient or others for use in non-native applications. The Provider will not provide Electronic Files in compressed formats. Recipient agrees to accept the files in the format provided by the Provider, and that Recipient's conversion or electronic file storage at the Recipient's requested site, shall be at Recipient's sole risk.

13. Recipient acknowledges:

    a. That the Electronic Files provided by the Provider are a graphical representation of the building in order to generate two-dimensional industry standard drawings.

    b. That the data contained in the Electronic Files may not be 100% accurate and should not be used for dimensional control, building layout, shop drawings, or any other similar purpose

    c. That any schedule of materials produced directly from the Electronic Files has not been checked for accuracy.

    d. That the information in the Electronic Files should be used only for comparative purposes and shall not be relied upon for accurate quantity estimates or used in establishing pricing.

14. Electronic Files provided by the Provider will only contain elements and content that the Provider deems necessary and appropriate to share. No specific Level of Detail (LoD) is implied or expected. The Recipient agrees that no proprietary content, MvParts or Revit Families or any other AutoCAD MEP or Revit MEP content shall be removed from the model and/or used for any other purpose but to support this specific project.

15. The Provider, at its sole discretion, may modify the Electronic files before they are provided to the Recipient. Such modifications may include, but are not necessarily limited to, removal of certain information. The Provider, at its sole discretion, may refuse to provide some or all Electronic Files requested by Recipient.

16. The availability of Electronic Files that were not prepared by the Provider is subject to the consent of the Owner or consultant that prepared those Electronic Files. The Provider will not negotiate with the Owner or consultant or repeatedly solicit the Owner or consultant to obtain such consent. Neither this Agreement and Waiver for Use of Electronic Files nor any such separate Consultant's consent may be assigned or transferred by Recipient to any other person or entity.

    Provider (Name of Company): _____

    Recipient (Name of Company): _____

    Recipient Address: _____

    Name of authorized Recipient Representative: _____

Title of authorized Recipient Representative: _____

E-mail address of authorized Recipient Representative: _____

Signature of authorized Recipient Representative: _____

Date: _____

NOTE: Select requested Electronic File format and complete applicable cost summary.

1. ☐ DWG / DXF Format - List of Drawings Requested: _____
_____

2. ☐ Revit Project Model Requested (Model only, no Views included)

The following costs are applicable to Delivery of Electronic Files (select one):
☐ CD-ROM ☐ Heapy FTP ☐ User's FTP site ☐ Flash Drive

Requested Electronic DWG / DXF file format (select one):

☐ 2010 DWG

Cost of Preparation of Division 27 Electronic DWG / DXF Files:

First Drawing: $50.00		$50.00
Additional Drawings $15.00 each	_____ x $15.00	= $ _____
Conversion to DXF Format: $5.00 additional/sheet	_____ x $ 5.00	= $ _____

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.)$ _____

All files will be bound together.

Requested electronic Revit file format (Select One):
☐ 2023 RVT

Cost of Preparation of Division 27 Electronic Revit Model Files:

Revit Project Model without Views	$500.00

Total Cost: (Please make check payable to Heapy Engineering and include a copy of this form.)$ _____

27 05 04 BASIC COMMUNICATIONS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 Refer to Section 26 05 04 Basic Electrical Materials and Methods which are hereby made part of Division 27 - Communications.

1.2 Temporary Telecommunication Services

A. The temporary communications for construction is provided by the Contractor. Refer to Division 01 – General Requirements.

B. The use of the permanent telecommunication system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.

C. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.

D. The complete temporary service shall comply with Telephone Company, Owner Facility, OSHA and all Code requirements.

1.3 Continuity of Service

A. Work shall be so planned and executed as to provide reasonable continuous service of existing systems throughout the construction period. Where necessary to disrupt services for short periods of time for connection, alteration or switch over, the Owner and Construction Manager shall be notified in advance and outages scheduled at the Owner's reasonable convenience.

B. Submit, on request, a written step-by-step sequence of operations proposed to accomplish the work. The outline must include tentative dates, times of day for disruption, downtime and restoration of services. Submit the outline sufficiently in advance of the proposed work to allow the Architect or Engineer and Construction Manager to review the information with the Owner. Upon approval, final planning and the work shall be done in close coordination with the Owner.

C. Shutdown of systems and work undertaken during shutdowns shall be bid as being done during normal working hours. If the Owner should require such work be performed outside of normal working hours, reimbursement shall be made for premium time expenses only, without mark up.

PART 2 - PRODUCTS

2.1 Access Panels

A. Provide ceiling and wall access panels where indicated on the drawings, or where otherwise required to gain access to concealed junction boxes, pull boxes, devices and equipment requiring service or adjustment.

B. Access panels (refer to paragraph C. below for more specialized drywall ceiling access panels) shall be steel construction (except where aluminum or stainless steel is specified) with concealed hinge and door with tamperproof screws. Locks in “secured” areas of the building shall have tamperproof. Panels shall be 18 inch x 18 inch size unless larger panels are shown

or required. Mounting frames shall be compatible with the material in which they are installed. Access panels shall be:

1. Standard flush type with overlapping flange for masonry and tile walls.
2. Plaster ceilings use style “AP”. Recessed type having the door recessed to accept a drywall panel insert, for drywall ceilings and walls, Milcor style “ATR” or equal.
3. Standard flush type for drywall ceilings and walls, Milcor style “M” or equal.

C. Access panels in fire rated shaft walls and in fire rated ceilings shall be "B" label or greater to match the rating of the wall or ceiling.

D. Materials used in plenums shall be rated for plenum use conforming to the ASTM E84 25/50 smoke development and flame spread restrictions.

PART 3 - EXECUTION

3.1 Workmanship

A. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect and Engineer shall have the right to stop the work if highest quality workmanship is not maintained.

B. Electrical work shall be performed by a licensed Contractor in accordance with requirements of the jurisdiction.

C. Communication work shall be performed by certified Contractor in accordance with the respective specification and system requirements.

3.2 Protection

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect or Construction Manager.

3.3 Cutting and Patching New Buildings

A. Refer to Division 01 - General Requirements for information regarding cutting and patching.

B. Plan the work well ahead of the general construction. Where conduits, wireways and cable trays are to pass thru walls, partitions, floors, roof or ceilings, place sleeves in these elements or arrange with the General Contractor to provide openings where sleeves are not practical. Where sleeves or openings have not been installed, sawcut or core drill holes and patch as required for the installation of this work, or pay other trades for doing this work when so directed by the Architect or Construction Manager. Any damage caused to the building in this work shall be repaired or rectified.

C. All sleeves and openings not used or partially used shall be closed to prevent passage of smoke and fire.

3.4 Painting

A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 27:

1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint and two finish coats of paint.
2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint and two finish coats of paint.
3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch up.
4. Apply Z.R.C. Galvilite, or approved equal, for touch-up and repair of previously galvanized surfaces.
5. Each backboard shall be painted with a minimum of two coats of flame retardant paint, all sides; gray enamel primer with gray matte enamel finish.

B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 of the Specifications. All rust must be removed before application of paint.

C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

3.5 Access Panels

A. Install access panels or pay general trade to do so. Final appearance is subject to approval by the Architect or Engineer.

B. Location of access panels shall be planned to clear ceiling lights, ceiling support grids and other obstructions so as to allow, wherever possible, full shoulder clearance beside the device to be inspected, adjusted or repaired.

C. Panels with recessed doors are to be fitted with insert panels of drywall or, those for plaster, infilled with plaster. Caution the Installing Contractor to provide appropriate framing with drywall or plaster beading to ensure a finished appearance. Shim strips may be required to bring the insert panel flush with the plane of the door and wall / ceiling.

3.6 Backboards

A. Where shown on the drawings in each TR, backboards shall be provided for wall mounting of communications equipment.

B. General

1. Backboard shall be 0.75 inch thick waterproof flame retardant plywood secured to structure.
2. Each board shall be painted.
3. Communication backboards shall be normally 4 foot x 8 foot mounted 6 inches above floor. Where other sizes are required, they will be noted on the drawings.

END OF SECTION

27 05 05 FIRESTOPPING

PART 1 - GENERAL

1.1 Firestopping assemblies shall be provided at penetrations of conduits, bus ducts, cables, cable trays and other electrical items thru fire rated floors, fire rated floor-ceiling and roof ceiling assemblies, fire rated walls and partitions and fire rated shaft walls and partitions. In addition, firestopping assemblies shall be provided at penetrations thru 0-hour rated floors. Refer to the drawings for fire rated building elements.

1.2 All existing penetrations which have firestopping which are disturbed as part of this project, shall have the existing firestop restored to its UL listed approved condition.

1.3 Firestopping assemblies shall be tested and rated in accordance with ASTM E814, E119 and listed in accordance with UL 1479, as published in the UL Fire Resistance Directory. Firestopping shall provide a fire rating equal to that of the construction being penetrated.

1.4 Firestopping materials, assemblies and installation shall conform to requirements of the OBC / Chapter 1, Section 106 and Chapter 7, Section 712 and the Authority Having Jurisdiction.

1.5 For those firestopping applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

1.6 Shop drawings shall be prepared and submitted for review and approval. Submittals shall include manufacturer's specifications and technical data of each material, documentation of U.L. firestopping assemblies and installation instructions. Submittals shall include all information required in OBC Chapter 1, Section 106 and Chapter 7, Section 712.

PART 2 - PRODUCTS

2.1 Firestopping materials shall be manufactured and/or supplied by Hilti, 3M, Rectorseal-Metacaulk, Tremco, Nelson, Specified Technologies or other approved manufacturer.

2.2 Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

2.3 Combination pre-set floor sleeve and wall firestopping assemblies shall be equal to STI EZ-Path Series 44+, STI FS400, Hilti CP 680 or Engineer's approved equivalent.

2.4 Conduit and conduit sleeves designated for future use shall be sealed utilizing Intumescent Fire Stop Plug STI FP400 or Engineer's approved equivalent.

PART 3 - EXECUTION

3.1 Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.

3.2 Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.

END OF SECTION

27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 Scope of Work

A. Work includes the provision of the technical grounding system including connections within Data Center/Main Technology Room/Technology Rooms/Telecommunications Enclosures.

B. Work includes bonding of technology pathways and equipment to the technical grounding system.

1.2 System Description

A. Provide a Telecommunications Primary Bonding Bar (PBB) in the Main Telecommunications Room. This ground bar shall be electrically bonded to the Building Main Electrical Service Ground with a minimum insulated, #2/0 coordinating with the drawing details for wire size, copper grounding conductor.

B. Provide a Telecommunications Secondary Bonding Bar (SBB) in each Telecommunications Room (TR)/Telecommunications Enclosure (TE) and at the telephone and CATV service entrance points.

C. Provide a Telecommunications Rack Bonding Bar (RBB) in every rack/cabinet in each TR. This ground bar shall be electrically bonded to the SBB within the TR with a minimum insulated, #6, copper grounding conductor.

D. Provide a Telecommunications Bonding Conductor (TBC) from each SBB to a local electrical panelboard ground. This bonding conductor shall consist of a minimum #6, bare copper grounding conductor. Provide a warning label attached to each Telecommunications Bonding Conductor at each end stating “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.”

E. Provide a Telecommunications Bonding Conductor (TBC) from each SBB to the PBB. This bonding conductor shall consist of a minimum #2/0, bare copper grounding conductor (size as required by distance per TIA-607). Provide a warning label attached to each Telecommunications Bonding Conductor at each end stating “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.”

F. Provide bonding between all joints of cable tray and ladder rack. Provide bonding to all conduit sleeves. Provide bonding to all technology equipment racks and cabinets within each TR/TE. Each equipment rack and/or equipment cabinet shall be separately bonded to the PBB/SBB.

G. Provide bonding from the Technology grounding system to the telephone and CATV demarc equipment and protector panels. Coordinate this grounding prior to installation of telephone and CATV services.

H. This contract shall be responsible for providing all equipment, cable tray, ladder rack, conduit and sleeve grounding in each TR/TE to the Building Grounding Electrode system.

I. All work shall be in compliance with NEC, Article 250 and EIA/TIE J-STD-607.

1.3 Quality Assurance

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

B. All equipment shall be UL listed.

1.4 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Job specific wiring diagrams.

1. Riser diagram showing conduit requirements with pull boxes, outlet boxes, part numbers of cable used, and a number of circuits in each conduit.

D. 30x42 floor plans at a scale of not less than 1/8 inch =1 foot -0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

1.5 Relevant Standards

A. The Telecommunications Grounding Installation shall comply with the following at a minimum:

1. All local, state and national codes
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA) 606, J-STD-607 and all applicable and current Technical Service Bulletins (TSB).

5. TIA-942 Data Center Infrastructure Guide

PART 2 - PRODUCTS

2.1 Telecommunications Primary Bonding Bar (PBB)

A. Ground bar shall be solid copper, 4 inches high, .25 inch thick, minimum 36 inches long with pre-drilled holes for standard-sized Lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.

B. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a minimum of 2 inch wall clearance. Insulators shall have a minimum voltage rating of 600V and a minimum Short Time Electrical Strength of 55kVv.

C. All connections shall be made with double-bolted, compression style grounding lugs. The bolts shall be stainless steel ¼ x 20 with hex-nut and lock washer.

D. Manufactured by StormCopper or equal by B-Line, Andrew, Tessco Technologies, CPI.

2.2 Telecommunications Secondary Bonding Bar (SBB)

A. Ground bar shall be solid copper, 4 inches high, .25 inch thick, minimum 12 inches long with pre-drilled holes for standard-sized Lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.

B. Ground bars shall be provided with insulated stand-off brackets for wall mounting providing a minimum of 2 inch wall clearance. Insulators shall have a minimum voltage rating of 600V and a minimum Short Time Electrical Strength of 55kVv.

C. All connections shall be made with double-bolted, compression style grounding lugs. The bolts shall be stainless steel ¼ x 20 with hex-nut and lock washer.

D. Bus bar and standoff assembly manufactured by StormCopper or equal by B-Line, Andrew, Tessco Technologies, CPI.

2.3 Telecommunications Rack Bonding Bar (RBB)

E. Ground bar shall be solid copper, rack mount with pre-drilled holes for standard-sized double Lugs and must be UL listed. Provide final length as required to accommodate grounding lug attachments.

F. Ground bars shall be provided at the top rear of every rack/cabinet.

G. All connections shall be made with double-bolted, compression style grounding lugs. The bolts shall be stainless steel ¼ x 20 with hex-nut and lock washer.

2.4 Telecommunications Bonding Conductor (TBC)

A. Insulated Conductors - Soft, annealed bare copper per ASTM B-3. Concentric, compressed stranded (class B or C Alternate ASTmB-787) per ASTM B-8, UL-83 and UL-854. Insulation Jacket: Nylon per UL-83. Insulation: High dielectric polyvinyl chloride per UL-83 and UL-854.

B. Uninsulated Conductor: Soft, annealed bare copper per ASTM B-3. Stranded as specified herein. Overall Finish: Gray polyvinyl chloride (PVC) per UL-824.

C. All connections shall be made with double-bolted, compression style grounding lugs. The bolts shall be stainless steel ¼ x 20 with hex-nut and lock washer.

D. RATINGS - Cables conform to the following standards:

1. UL-83 for THHN-THWN Cdrs.
2. Federal Specification J-C-30B

2.5 Bonding Conductors

A. Conductor shall be minimum #6AWG and may be either stranded or solid, insulated or bare.

B. Cable as manufactured by Superior/Essex, Rome, AIWC.

C. All connections shall be made with double-bolted, compression style grounding lugs. The bolts shall be stainless steel ¼ x 20 with hex-nut and lock washer.

PART 3 - EXECUTION

3.1 General

A. The telecommunications grounding system shall provide an electrically continuous, low impedance path for all connected telecommunications equipment and pathways.

B. When using grounding conductors installed in rigid, ferrous metallic conduit, both ends of the bonding conductor must be bonded to the conduit ends.

C. The bonding conductors shall have no splices or connections.

D. The bonding conductor shall be connected to the building main electrical grounding system through the use of exothermic weld, listed lugs, listed pressure connectors, listed clamps, or other listed means.

E. All metallic telecommunications pathways and equipment within telecommunications spaces shall be bonded to the local SBB/PBB utilizing Bonding Conductors (BC).

3.2 Wiring

A. In large buildings with multiple floors and multiple riser closets per floor, the SBB in the Telecommunications Room (TR) at the top floor and every third floor shall be joined with the Grounding Equalizer (GE).

B. Refer to drawings for specific location and arrangement of telecommunications Bonding Backbone and Telecommunications Ground bars.

C. The drawings do not indicate specific routes for telecommunications grounding cables. The Telecommunications Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the grounding system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Telecommunications Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

D. The Main Telecommunications Room shall be provided with the Telecommunications Primary Bonding Bar (PBB). The PBB shall be bonded to the building electrical system ground and shall be bonded to one additional building electrical system ground (such as building steel).

E. Each Telecommunications Room (TR)/Telecommunications Enclosure (TE) shall be provided with a Telecommunications Secondary Bonding Bar (SBB).

F. Provide a Telecommunications Bonding Conductor (TBC) from each TGB.

3.3 Grounding/Bonding Connections

A. Ground all backbone cable sheaths, shield drain wires from all voice/data horizontal cable, equipment racks and equipment to the local TGB / TMGB.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by ANSI/TIA-607B.

C. All joints of all cable tray and ladder rack shall be bonded together. When bonding to painted equipment, methods shall be utilized to ensure continuity of grounding connection.

D. Telephone and CATV Service entrance equipment and primary protection panels, shall be bonded to the technical grounding system. Coordinate with serving utilities regarding configuration of grounding connections.

E. All connection to ground bars (TGB, TMGB) shall be made using listed lugs appropriate for mounting provisions in the supplied ground bar.

3.4 Testing General

A. The Contractor shall be responsible for testing the complete technology grounding system.

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

C. Test reports shall be provided to indicate.

1. Impedance values across each TBB from the TMGB to the TGB.
2. Impedance values across the TBC from the TMGB to the main electrical service ground.
3. Impedance values across each GE between TGB on a common floor.

D. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

E. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

F. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

G. Instruments required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner / Architect / Engineer prior to application.

3.5 Labeling

A. The Contractor shall be responsible for labeling all telecommunications grounding equipment, cable, etc. in accordance with the guidelines as described herein.

B. Each telecommunications ground bar shall be provided with a warning label to read:

1. “WARNING: Building telecommunications grounding system. Do not remove or disconnect without prior approval from building Telecommunications Department.”

C. Each Telecommunications Bonding Conductor (TBC, TBB, GE, etc.) to be provided with a label indicating source and destination ground bars.

3.6 As-Built Documentation

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer’s stamp.

C. Copy of all test reports.

D. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

1. System schematic and block diagrams for technology grounding system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

3.7 Warranty

A. The entire grounding and bonding system as specified herein shall be guaranteed against defects in workmanship and materials for a period of one (1) year as described herein. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION

27 05 28 COMMUNICATIONS SYSTEMS PATHWAYS AND SUPPORT EQUIPMENT

PART 1 - GENERAL

1.1 Scope of Work

A. Work consists of pathways to carry communication wiring of all descriptions, including empty conduits, conduit sleeves, cable tray, ladder rack, cable management systems, innerduct, etc.

B. Work includes support equipment for telecommunications cabling including backboards, rough-in boxes and cabinets.

C. Work includes new cable management systems to support all installed communications cabling per standards and manufacturer's recommendations where portions of the cabling are run in areas with insufficient or unusable existing pathways.

1.2 Quality Assurance

A. Communications pathways and support equipment shall be closely coordinated with other trades to provide adequate access, appropriate clearances and required separation between systems.

1.3 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.4 Drawings

A. The drawings, which constitute a part of these bid documents, indicate the general route of the pathways to carry communication wiring systems. Data presented on these drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification, of all dimensions, routing, etc., is directed.

B. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.5 Related Work by Others

A. Communications cabling shall be included as stated in the specification section for each individual system.

PART 2 - PRODUCTS

2.1 Wireways shall be metal trough with a removable hinged cover and generous knockout arrangement. Provide necessary ells, tees and fittings for a complete installation. All components shall be hot dip galvanized after fabrication or provided with a rust inhibiting phosphatizing coating and finished in baked enamel. All hardware shall be plated to prevent corrosion. Wireways shall be manufactured by Square D, Weigman, Hoffman or Austin.

2.2 Cable Management System

A. Provide pre-manufactured cable supports as manufactured by Panduit, Cooper B-Line, Caddy, Mineralac, Mono-Systems or Rayco. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bend, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

D. Bridle rings shall not be acceptable.

2.3 Cabinets

A. Telephone, communication and data systems cabinets shall be provided by the same manufacturer as panelboards with matching trim, hinges, latches, locks, finish and color unless included as part of another communication system specification. Refer to Section "Panelboard" and Section "Cabinets and Enclosures".

2.4 Backboards

A. Refer to Section 27 05 04 – Basic Communications Materials and Methods.

2.5 Rough-In Boxes

B. Refer to drawings for types, quantities and configurations of outlet boxes used to serve communications cabling.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for pathway types, locations and routing.

B. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 ft.
2. Conduit and cable used for electrical power distribution – 1 ft.
3. Fluorescent lighting – 5 inches.
4. Power lines up to 5 kV – 5 inches.
5. Power lines over 5 kV. – 24 inches.

C. Backboards and cabinets shall be installed in telecommunications rooms/spaces to support telecommunications equipment and wiring. Coordinate locations of backboards and cabinets with Owner prior to installation.

D. Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means; refer to 27 05 33 Raceway and Boxes for Communications Systems paragraph.

E. Provide conduit pathways in areas that have exposed structure or plastered ceilings to provide a wiring pathway for all communication cables from these areas to above suspended ceilings or in the nearest telecommunications closet.

F. No non-metallic or combustible materials shall be installed in ceiling or other plenums used for circulating room air used for heating, ventilation or cooling.

G. Cabling pathways shall be installed with a minimum of 6" clearance above and 6" clearance below. It shall not be acceptable for any other building systems including piping, ductwork, equipment, etc. to infringe upon this clear space.

H. In no circumstances are components of other building system allowed to run through or penetrate the plane of the cable tray channel. This includes piping/conduit passing through cable tray.

3.2 Conduit Systems – Coordinate with Division 26 Contractor to ensure that conduit system installed for telecommunications cabling shall conform to the following:

A. No section of conduit shall be longer than 100 feet between pulling points.
B. No more than two 90 deg. bends in a section of conduit between pulling points.
C. Pulling points/pullboxes shall not be used to change direction of the conduit pathway. Pulling points/pullboxes shall be placed "in-line" with the conduit pathway.
D. Each section of conduit shall be labeled for length, destination closet and origination closet.
E. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.
F. Conduit and wiring above accessible ceilings shall be run as high as possible, above piping and ductwork, so as to not interfere with mechanical trades, access to mechanical and electrical devices and to allow freedom to remove ceiling panels.
G. Provide a No. 12 gauge pull wire or nylon pull cord in each empty conduit run.

3.3 Wireways

A. Wireways shall be supported with factory made hangers designed expressly for this purpose and 0.375 inch diameter solid hanger rods approximately 5 ft. on center or approved strap hangers for surface mounting.

3.4 Ladder Rack

A. All fittings, supports, splices, etc. for the runway system shall be installed to provide a complete assembly – including fasteners, hardware and other items required to complete the installation as indicated on the drawings.

B. Cable runway shall be capable of carrying a uniformly distributed load of 95 lbs./ft. on a 5 foot support span with a safety factory of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capacities.

C. "Ladder Type" cable trays shall be supported from continuous wall inserts and shelf brackets in a manner to permit laying cables in the trays without interference of a supporting rod on one side. All inserts, supports and necessary wall modifications and bracing shall be furnished by this Contractor.

3.5 Cable Management System

A. The drawings do not indicate specific routes for telecommunications cables. The Division 27 Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental management pathways and systems so that

all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc., the Division 27 Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

B. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a cable management system. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances:

1. Motors and transformers – 4 feet.
2. Conduit and cable use for electrical power distribution – 1 feet.
3. Fluorescent lighting – 5 inch.
4. Power lines up to 2kVA – 5 inch.
5. Power lines over 5kVA – 24 inch cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

C. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

3.6 Cabinets

A. Mount top of wall mounted cabinets 6 feet-0 inches above floor. Coordinate location of recessed cabinets to be accessible and to avoid interference with other equipment and trades.

B. Each cabinet shall be fitted with a full size 0.75 inch thick backboard for mounting terminal strips, equipment, etc.

3.7 Identification / Labeling

A. All continuous communications pathways such as conduit, cable tray, etc. shall be labeled to indicate origination and destination. Label shall be applied every 50 feet wherever accessible or subject to administration. Coordinate label information with Owner.

B. Label shall consist of mechanically printed, permanent adhesive label, applied to cleaned / prepped area of raceway.

3.8 As-Built Documentation

A. Provide a complete set of architectural floor plan drawings indicating final communications pathway systems with accurate "as-built" locations to show the actual route for the communications systems pathways.

B. Drawings shall indicate each pathway type and provide sizing information such as conduit/innerduct diameter, cable tray width, cable management ring size, etc.

C. Component Service Manuals: Include information for testing, repair, troubleshooting, assembly, disassembly, and required / recommended maintenance intervals for all types of pathways.

3.9 Restore fire rating and smoke stoppage integrity where all wireways, raceways and cable trays pierce walls, floors and ceilings by sealing with approved means.

END OF SECTION

27 11 00 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 Scope of Work

A. The intent of this specification section is to cover the materials and installation of a communications equipment room fitting system as outlined herein and as detailed on the drawings. Work shall consist of:

1. Telecommunications Room termination and cable management including racks, cabinets, ladder rack, backboards, backboard mounted wire management, etc.
2. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.
3. Cable management system within racks and cabinets.
4. System labeling conforming to EIA/TIA-606 standards.

1.2 System Description

A. Termination Equipment – Racks and Cabinets

1. Racks and cabinets with wire management systems in the IT Closets.

B. Cable Management – Ladder rack, rack mounted horizontal and vertical cable management, backboards, backboard mounted cable management.

C. Cabling pathways including raised floor cable tray, overhead fiber duct, overhead ladder rack, innerduct, etc.

1.3 Quality Assurance

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA. BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.5 Relevant Standards

A. The structured cabling installation shall comply with the following at a minimum:

1. All local, state and national codes.
2. The National Electric Code (NEC)
3. The National Electrical Safety Code (NESC)
4. Electronic Industries Alliance (EIA) / Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 Product Equivalency

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals **if all specified features are provided**. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

2.2 Open Style, standard 19" rail Racks

A. Open style /four post data racks shall be 19 inches wide, 84 inches high, and shall meet EIA standards. Racks shall be listed to the UL 1863 Standard for Communication Circuit Accessory. Both vertical and horizontal cable management systems must be provided on all relay racks. All racks must be grounded to the building technical grounding system.

B. Provide a full height front/rear vertical wire management panel with integral cable spools with each floor mounted rack on each side. Where multiple racks are ganged together, there shall be one vertical wire management section between each two racks and one additional section at each end of the line-up.

C. 4-post racks shall have front and rear perforated doors and sides.

D. Provide one - six outlet power strip with integral surge suppression and a 10 ft. cord with 20A plug in each rack. Each plug strip to connect to rack mounted UPS unit. Refer to drawings for quantities and locations. Power strip must rack mounted.

E. Coordinate location at each rack with Owner.

F. Racks and cabinets shall be manufactured by ADC, Great Lakes, Middle Atlantic, Panduit, Hubbell, XMARK, Rittal, Chatsworth, B Line or APW.

G. Refer to drawings for quantities and arrangement.

2.3 PDU - Provide the following PDU units in each TR:

A. Provide all required 120V and 280V power distributed units through rack as required by installed equipment:

1. PDU's shall have IP monitoring and switchable outlets.
2. **PDU's shall be "zero-U" mounting with the cord exiting the top of the PDU. A minimum cord length of 6' is required. Refer to drawings for locations.**
3. PDU shall have an onboard display.
4. PDU shall have the ability to connect to other types of sensors (such as a thermal probe).

B. Acceptable manufacturers: Liebert, Geist, APC**.**

2.4 UPS Units - Provide line interactive, battery back-up, power conditioning UPS, rack mounted in each TR to serve network electronics as indicated on the drawings. Unit shall utilize combination of battery and microprocessor regulation to provide protection from brownouts and over voltage. UPS to have the following features at a minimum:

A. 2200VA capacity as indicated on drawings

B. Output Operating Range – 120V (<3000VA) nominal

C. Communications – Unit shall provide an Ethernet based SNMP management interface, through the LAN to provide remote diagnostics and alarm conditions. Provide vendor management software with all applicable licenses.

D. Expandability – Unit shall provide for the connection of external battery packs in modules to extend the total unit run-time.

E. 2200VA minimum of six (6) NEMA 5-15R receptacles switched and conditioned. 12 feet line cord with 120V 20A straightblade plug. Final plug configurations shall be coordinated with equipment served. Any accessories or customization of Uninterruptable Power Supply unit shall be the responsibility of the contractor prior to ordering.

F. Rack mounted.

G. Unit as manufactured by APC, Liebert, Chloride, or Tripp Lite, Minute Man.

H. Refer to drawings for sizes, quantities and configuration.

2.5 Backboards

A. Where shown on the drawings in each TR, backboards shall be provided for wall mounting of devices and technology equipment.

B. General

1. Backboard shall be 0.75 inch thick waterproof flame retardant plywood secured to structure.
2. Each board shall be painted with fire retardant paint.
3. Backboards shall be normally 4 ft. x 8 ft. mounted 6 inch above floor. Where other sizes are required, they will be noted on the drawings.

C. Refer to drawings for quantities and arrangement.

2.6 Backboard Mounted Cable Management

A. D-Rings

1. Non-conductive, smooth bearing. Available in 2 x 2, 3 x 3 or 3 x 5. Size as required for 50 percent spare capacity.
2. Provide on backboards for management of cabling.

B. Slotted Raceway

1. Provide non-metallic, wall mounted slotted raceway with covers, Available in 2x2/3x3/4x4. Refer to plans for locations. Size as required for 50 percent spare capacity.

2.7 Overhead Ladder Rack

A. Runway shall be tubular steel, ladder type with 1.50 inch stringer height with welded rungs. Refer to plans for width. Stringer side rail shall conform to the minimum chemical and mechanical properties of ASTM A513 Grade 1008 steel.

B. Cable runway shall be flat black powder coat including all fittings, hardware and accessories to provide a unified color for the complete instllation.

C. All fittings, supports, splices, etc. for the runway system shall be installed to provide a complete assembly – including fasteners, hardware and other items required to complete the installation as indicated on the drawings.

D. Cable runways shall be capable of carrying a uniformly distributed load of 95 lbs./ft. on a 5-foot support span with a safety factory of 1.5 when supported as a simple span. Load and safety factors specified are applicable to both side rails and rung capacities.

E. Ladder Rack as manufactured by B-Line, Damac, Hubbell, ICC, Great Lakes.

F. Refer to drawings for quantities and arrangement.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for quantity and arrangement of Telecom Room equipment.

B. Where cabling is routed along backboards, utilize wall mounted cable management systems to provide cable support at an interval no less than 48 ~~60~~ inch O.C.

C. Telecommunications Rooms – Provide ladder rack in telecommunications rooms in configurations as indicated on the drawings.

D. Provide cable drop-outs (waterfall) at each rack/cabinet location for management and support of cables drops into racks/cabinets.

E. Where ladder rack is routed above racks/cabinets, provide additional support (mounting plate)/ anchors to attach the ladder rack to the racks/cabinets.

3.2 Telecommunications Rooms

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

A. Provide ladder rack in telecommunications rooms in configurations as required by final room layout.

B. Coordinate layout of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate layout of telecom rooms with electrical plans and locations of electrical outlets.

D. Layout of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.3 Grounding – Reference Section 27 05 26

3.4 Programming – Not Applicable

3.5 Identification/Labeling

A. The Contractor shall be responsible for labeling all supplied communications equipment, in accordance with the guidelines as described herein.

B. Equipment racks/cabinets shall be labeled to indicate closet designation and sequential number within each closet.

C. On renovation projects where there already exists a numbering scheme, this contractor shall be responsible for maintaining and extending that numbering scheme as directed by the Owner.

D. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.6 Testing - Not Applicable

3.7 Coordination With Communications Service Providers – Not Applicable

3.8 Training Requirements – Not Applicable

3.9 As-Built Documentation

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer’s stamp.

C. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

1. Racks/Cabinets
2. Ladder Rack
3. Power Strips
4. Cable Tray

D. Technology drawings updated with final as-built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

1. AutoCAD architectural floor plans at a scale of 0.25 inches=1 foot-0 inches on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each IDF closet

and the MDF closet. This layout shall include the racks, backboards, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans. These drawings shall be as-built conditions.

3.10 Warranty

A. The entire system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

END OF SECTION

27 13 23 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 Scope of Work

A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of:

1. Backbone cabling between telecommunications rooms including termination, testing and labeling.
2. Backbone cabling between buildings including termination, testing and labeling.

1.2 System Description

A. Data Backbone cabling system shall consist of:

1. Backbone cabling as specified herein between each communications equipment room. Refer to the drawings for specific cabling requirements.
2. Intra-building backbone cables as specified herein. Refer to drawings for specific requirements.
3. Backbone Cable Termination equipment on both ends of each backbone cable.
4. Testing and labeling.

1.3 Quality Assurance

A. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 Contractor Qualifications

A. Work shall be performed by a BICSI certified Telecommunications Contractor that is properly certified in the cabling system being installed. Contractor's requesting pre-approval from the Engineer to perform the work as specified in this section shall meet the following requirements:

B. The Contractor must have an on-staff, full time RCDD. The personnel assigned to project manager for this project must be a current RCDD in good standing.

C. The personnel assigned to project foreman at the project site must be a minimum BICSI Level II certified installer.

D. The Contractor must have at least one BICSI Level I certified installer in the daily work crew.

E. The Contractor must hold a current certification from the manufacturer of the proposed cabling system solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties as specified herein.

F. Requests for consideration shall be sent to the Construction Manager/Architect/Engineer (by mail or fax) and shall include the following:

1. Copy of the BICSI RCDD certificate for the Contractor's on-staff, full time project manager.

2. Copy of the BICSI Level I, II and III certificate(s) for the Contractor's on-staff, full time installation personnel. Prior to commencement of work, the Contractor shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.
3. Copy of the Voice/Data System Manufacturers Approval Certificate indicating that the Contractor is a certified installer of the proposed voice and data Cabling System Solution.
4. It will not be the responsibility of the Engineer to recognize or respond to incomplete or incorrect requests.

G. **It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to following requirements:**

1. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project's construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.
2. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.

1.5 Shop Drawings

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

1.6 Relevant Standards

A. The Structured Cabling Installation shall comply with the following at a minimum:

1. All local, state and national codes.
2. The National Electric Code (NEC),
3. The National Electrical Safety Code (NESC).
4. Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

PART 2 - PRODUCTS

2.1 Structured Cabling System

A. The entire voice/data vertical fiber optic backbone cabling solution shall be a listed EIA/TIA cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source. Provide a listed Cabling System Solution utilizing cable/components from the following list of acceptable manufacturers:

1. Cable – ADC/Krone, Belden (CDT), Berk-Tek, Commscope, Corning, Draka, OCC, Mohawk, Molex, 3M, HCM.
2. Components – ADC/Krone, Systimax, Belden (CDT), Corning, Hubbell, Leviton, Molex, Ortronics, Panduit, Siemon, Wiremold.

B. Indoor backbone cabling shall be plenum rated.

C. Outdoor and underground fiber shall be dual OFNP / OSP rated.

2.2 Data Backbone Cable - Fiber

A. Outdoor type shall be indoor/outdoor, armored, type OFNP with UV-resistant outer jacket,

1. Singlemode – OS2
2. Cable shall be terminated on both ends as specified herein.
3. Provide a 3m Figure 8 maintenance loop at the termination point. Consult the cable manufacturer for the recommended loop radius.
4. Each cable shall be labeled on both ends and at all accessible points. Coordinate labeling scheme with Owner and submit to Engineer for review.
5. All fiber shall be run in innerduct.
6. Refer to drawings for quantities and locations.

2.3 Communications Equipment Room Termination Equipment

A. Frames

1. Rack and Cabinet Mounted Installation - Provide fiber optic, rack mounted termination cabinets including patching bulkheads and fiber splicing management. Provide cabinets with bulkhead space as required for termination of associated fiber cabling, plus xx spare.. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. . Each connected port to be labeled as coordinated with Owner. Refer to drawings for locations of rack mounted patch panels.

B. Connectors

1. Individual
   a. Provide bulkheads with type LC couplers for termination of all fiber cabling.

2.4 Fiber Terminations – Field terminated

A. Singlemode

1. All fiber terminations at patch panels shall be done utilizing fusion splice (core alignment) pigtails/mechanical crimp pre-loaded connectors/hot-melt pre-loaded connectors/anaerobic pre-loaded connectors.

2. Provide factory recommended polishing of fiber ends as required.

B. Polarity

1. Contractor shall coordinate polarity scheme with owner. (A-no change, B-Transpose, C-Pair wise flip).

2.5 Patch Cables

A. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:

1. Data Backbone - Provide three (3) 2 meter 2 strand fiber jumper cables at each termination point for each fiber backbone cable. Coordinate jumper type and length with Owner.

PART 3 - EXECUTION

3.1 General Installation

A. Refer to drawings for quantity and arrangement of backbone cabling system.

B. Make all backbone terminations at TR termination equipment at each end utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

C. Coordinate all cable and termination equipment color requirements with Owner / Engineer. Color coding shall be consistent for all like equipment.

D. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.2 Wiring Installation

A. Backbone cabling shall not exceed the maximum lengths for the specified rating. The contractor shall be responsible for verifying adequate cable pathways to limit cable lengths prior to installation. Where existing or designed pathways do not allow for compliance to distance limitations for backbone cabling, the contractor shall provide alternate pathway routes to the Engineer for review.

B. Exterior – all cables shall be run duct bank system or overhead as shown on drawings.

C. The drawings do not indicate specific or complete routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

D. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a Cable Management System. Cable management system shall provide support no more than 5 feet on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches
2. Conduit and cable used for electrical power distribution – 12 inches
3. Fluorescent lighting – 5 inches
4. Power lines up to 2kVA – 5 inches
5. Power lines over 5kVA – 24 inches
6. Hot water/steam lines - Bare –18 inches, Insulated – 6 inches

E. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

F. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within

component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

G. Data backbone cables shall be handled and installed with extreme care. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 10 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

H. Provide adequate cable slack at each Communications Equipment Room termination equipment as follows:

1. Provide adequate slack to move the data termination equipment a minimum of 10 feet in any direction.

I. Where cables are installed in conduit, the conduit system shall conform to the following:

1. No section of conduit shall be longer than 100 feet between pulling points.
2. No more than two 90 deg. Bends in a section of conduit between pulling points.
3. Pulling points/pullboxes shall not be used to change direction of the conduit pathway. Pulling points/pullboxes shall be placed "in-line" with the conduit pathway.
4. Each section of conduit shall be labeled for length, destination closet and origination closet.
5. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

J. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

3.3 Telecommunications Rooms

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

3.4 Identification/Labeling

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. Each cable, jack cross-connect and patch panel shall be labeled at every location where they are administered per TIA/EIA-606.

C. Backbone cable shall be identified and labeled on the blocks and patch panels. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer. DYMO style labels, cloth or plastic "numbers" or hand written labels WILL NOT BE ACCEPTED.

D. This contractor shall be responsible for creating/maintaining the numbering scheme as directed by the Owner.

E. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.5 Testing General

A. The Contractor shall be responsible for testing all installed structured cables.

B. The Contractor shall submit a written fiber test plan to the Engineer for review. The test plan shall include the following.

1. Make/Model of fiber inspection unit and analytical software.
2. Make/Model of testers being utilized for power meter and OTDR tests.
3. Launch cable length/attenuation for SM and MM.
4. Automatic or manual settings for length/pulse/time. If manual, indicate how the settings will be determined.
5. Pass/fail criteria for Power Meter Tests.

C. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

D. The Contractor shall be responsible for performing the following fiber optic testing:

1. Fiber end-face inspection per 7. IEC 61300-3-35 inspection standards
2. OTDR (with launch and receive cords) bi-directional
3. OLTS/power meter. Test shall include a report showing the Refence Cord and Reference test cord along with actual results.
4. The OTDR results shall be submitted in digital format (trace files) along with required viewer software
5. The power meter tests shall be submitted in digital format directly as saved from the test equipment along with software viewer.

6. The visual inspection tests shall be submitted in digital format directly as saved from the test equipment along with software viewer.

E. The contractor shall provide independent 3rd party testing of 10 percent of all installed voice and data outlets. This independent testing shall be assembled in a separate binder and submitted along with the test reports in the O&M manual. Significant discrepancies in test results between the independent testing and the Contractor's testing shall be addressed by the Contractor to the Engineer and the Owner's satisfaction.

F. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

G. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

H. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

I. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

J. The Owner / Architect / Engineer reserve the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined

that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed voice/data/fiber cabling plant and revising/updating all test documentation as required.

K. Instruments required for tests shall be furnished by the Contractor.

3.6 Testing Data Backbone Fiber

A. Single-mode - Provide an end-to-end attenuation test at 1310 nm and 1550 nm for all single-mode fiber optic cable links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-7; "Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant". Provide a hard copy of the test results to the Owner. Launch cable shall be a minimum of 500 meters for OTDR tests. In lieu of bi-directional testing, the Contractor may utilize a receive cable of sufficient length to allow accurate readings of the final end connector pair.

B. Fiber cables shall be pre-tested for length and OTDR on the spool prior to installation. A variance of more than 3dB from the Manufacturer's OTDR or a length discrepancy of more than 10 percent shall be reported to the Owner.

C. Each optical fiber cable strand and jack shall be electronically verified based upon the following criteria:

1. Visual inspection with analytical software to verify clean, undamaged, and foreign matter free end faces.
2. Continuity Test
3. Insertion Loss Test
4. Return Loss Test
5. Optical Time Domain Reflectometer (OTDR) (EIA/TIA – TSB140)
6. Bandwidth Certification or Link Confidence Testing (LCT)
7. The raw information which is generated from these test methods will be compiled, organized and presented as an indication of the installed fiber optic network's compliance to specifications and overall quality. These test results shall be included in the O&M manuals.

D. The fiber plant shall be certified to meet the following performance criteria:

1. SM insertion loss < 0.3 dB
2. SM ORL < -26 dB

3.7 System Acceptance Requirements

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor's expense prior to system acceptance.

3.8 As-Built Documentation

A. Refer to Section 27 05 01 for submittal requirements.

B. Copies of all approved shop drawings with the Engineer's stamp.

C. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software

where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

1. Fiber Test Results - The raw information which is generated from these test methods will be compiled, organized and presented as an indication of the installed fiber optic network's compliance to specifications and overall quality. These test results shall be included in the O&M manuals.
2. Single-mode Fiber test results - Provide an end-to-end attenuation test at 1310 nm and 1550 nm for all single-mode fiber optic cable links after installation and terminations. The dB loss test shall be performed in accordance with EIA/TIA-526-7; "Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant". Provide a hard copy of the test results to the Owner. Each optical fiber cable and jack shall be electronically verified based upon the following criteria:
   a. Continuity Test
   b. Insertion Loss Test
   c. Return Loss Test
   d. Optical Time Domain Reflectometer (OTDR)
   e. Bandwidth Certification or Link Confidence Testing (LCT)

D. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.9 Warranty

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials for a period of three (3) years. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.10 Certification

A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.

B. Project final completion will be pending delivery of manufacturer’s warranty certificate.

END OF SECTION

27 15 13 COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 2 - GENERAL

1.1 Scope of Work

B. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of

1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels. Boxes and conduit are being provided by Division 26 contractor.

2. Voice and data copper station cabling from work area outlets to telecommunications rooms including termination testing and labeling.

3. Voice and data work area equipment cords.

4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.

1.2 System Description

B. Voice and Data station cabling (copper) system shall consist of:

1. Workstation outlet jacks.

2. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Local Telecom Closet (TR-0X) or the Main Telecom Room (ER).

3. Station Cable Termination Equipment in each TR.

4. Final connections of the station cabling at the workstation outlet jack and the termination equipment in each TR.

5. Cross connects / patch cable to connect work area outlets to backbone / network electronics.

6. Testing and labeling.

1.3 Quality Assurance

B. All work shall be installed in compliance with the latest edition of the Commercial Building Telecommunications Wiring Standard EIA/TIA, ANSI, ICEA, BICSI Standards, applicable National Electric Code Sections, Ohio Building Codes.

1.4 Contractor Qualifications

B. Work shall be performed by a BICSI certified Telecommunications Contractor that is properly certified in the cabling system being installed. Contractor's requesting pre-approval from the Engineer to perform the work as specified in this section shall meet the following requirements:

C. The Contractor must have an on-staff, full time RCDD. The personnel assigned to project manager for this project must be a current RCDD in good standing.

D. The personnel assigned to project foreman at the project site must be a minimum BICSI Level II certified installer.

E. The Contractor must have at least one BICSI Level I certified installer in the daily work crew.

F. The Contractor must hold a current certification from the manufacturer of the proposed cabling system solution. This certification must be valid for both installation and testing and shall enable the Contractor to offer the full manufacturer's product and applications warranties as specified herein.

G. Requests for consideration shall be sent to the Construction Manager/Architect/Engineer (by mail or fax) and shall include the following:

1. Copy of the BICSI RCDD certificate for the Contractor's on-staff, full time project manager.

2. Copy of the BICSI Level I, II and III certificate(s) for the Contractor's on-staff, full time installation personnel. Prior to commencement of work, the Contractor shall submit the resume of personnel assigned to the project. Any approval given during bidding shall be based upon the information submitted. Change in approved personnel prior to completion of the project shall be brought to the attention of the Engineer for review.

3. Copy of the Voice/Data System Manufacturers Approval Certificate indicating that the Contractor is a certified installer of the proposed voice and data Cabling System Solution.

4. It will not be the responsibility of the Engineer to recognize or respond to incomplete or incorrect requests.

H. It shall not be acceptable for any portion of the work specified herein to be performed by a sub-contractor unless such sub-contractor has been pre-approved by the Engineer in writing. Refer to following requirements:

1. The Engineer will respond in writing to applicants who meet the requirements of this specification or to the project's construction manager. This response will serve as formal notice that the Contractor is approved for the listed project.

2. Contractors who have not received approval from the Engineer prior to issue of formal contracts will not be approved to perform the work outlined in this specification section regardless of their qualifications.

1.5 Shop Drawings

B. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

C. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

D. Qualifications

1. Copy of current BICSI and manufacturers certifications. Certifications that are past the expire date will not be accepted.

2. A statement of contractor's qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

1.6 Relevant Standards

B. The Structured Cabling Installation shall comply with the following at a minimum:

1. All local, state and national codes

2. The National Electric Code (NEC)

3. The National Electrical Safety Code (NESC)

4. Electronic Industries Alliance (EIA)/ Telecommunications Industry Association (TIA) 526, 568, 569, 598, 606, J-STD-607, 758 and all applicable and current Technical Service Bulletins (TSB).

1.7 Related Sections

B. The following specification sections shall be deemed to be included in part or in whole and require close coordination to ensure total system interoperability and compatibility:

C. 27 11 00 – Communications Equipment Room Fittings

D. 27 13 23 – Communications Optical Fiber Backbone Cabling

PART 3 - PRODUCTS

2.1 Structured Cabling System

B. The entire voice/data horizontal station cabling solution shall be a listed EIA/TIA cabling system solution from a single Manufacturer/Source as required by the Manufacturer/Source. Provide a listed Cabling System Solution utilizing cable/components from the following list of acceptable manufacturers:

1. Cable –Systimax, Belden (CDT), Berk-Tek, Commscope, General BICC, Mohawk,.

2. Components –Systimax, Belden (CDT), Hubbell, Leviton, Ortronics, Panduit, Siemon, Wiremold.

C. Horizontal cabling systems shall be permanent link configuration for voice and data.

D. Horizontal (station) cable shall be plenum rated.

E. Data station cabling shall be terminated utilizing EIA/TIA 568B standards.

F. Cables installed in underground conduits shall be wet label/ indoor/outdoor rated.

1. Where wet label cables are required to feed floor boxes, the contractor shall transition cable back to plenum rated cable by providing “consolidation point” above ceiling consisting of Category rated 110 block and plenum enclosure and make transition from wet label cable to indoor plenum rated cable.

2. Where indoor/outdoor rated CM cables are run through plenum spaces, the contractor shall provide rigid metallic conduit and sealed junction boxes to completely enclose the cable route through the plenum space.

3. Refer to drawings for locations with floor box outlets. Transition shall not affect system warranty.

2.2 Data Station Cable

A. Category 6, 4 twisted pair, non-shielded (UTP) station cable (capable of transmissions speeds in excess of 1.2 Gb/s and supporting IEEE 802.3ab Gigabit Ethernet) shall be used for serving data outlets. Cable shall be sequentially marked at 2 foot intervals. Color as selected by Owner.

B. Category 6A, 4 twisted pair, non-shielded (FUTP)/shielded (STP) cable, rated for minimum 500 Mhz, support for 10Gig Ethernet at 100 m. Cable shall be sequentially marked at 2 foot intervals. Color as selected by Owner.

C. Each cable shall be a dedicated home run from the workstation outlet jack to the data termination equipment in the local TR. Terminate cable at the workstation and at the TR termination equipment as specified herein and as indicated on the drawings.

D. Cable shall be labeled at both ends to indicate patch panel and port served. Coordinate labeling scheme with Owner and submit to Engineer for review.

2.3 Voice Station Cable

A. Category 6, 4 twisted pair, non-shielded (UTP) station cable (capable of transmissions speeds in excess of 1.2 Gb/s and supporting IEEE 802.3ab Gigabit Ethernet) shall be used for serving data outlets. Cable shall be sequentially marked at 2 foot intervals. Color as selected by Owner.

B. Each cable shall be a dedicated home run from the workstation outlet to the voice termination equipment in the local TR. Terminate each cable at the workstation outlet and in the TR as specified herein and as indicated on the drawings.

C. Cable shall be labeled at both ends to indicate patch panel / punch block and port served. Coordinate labeling scheme with Owner and submit to Engineer for review.

2.4 Workstation Outlets

A. Data Jacks

1. Served from Category 6/6A cable shall be Cat. 6/6A rated, 8 position, 8 wire flush mounted modular jack (RJ-45). Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner. Modular mounting straps under duplex outlet faceplates shall not be acceptable.

2. Modular Plug Terminated Link (MPTL) – TIA 568.D-2 may be utilized to serve the following PoE powered end devices in lieu of surface outlets at the device location. Contractor shall be responsible for verifying the selected solution plug will fit in the equipment.

a. IP Cameras

b. Wireless Access Points (WAPs)

B. Outlet Components

1. Faceplates shall be modular 6 port and shall accept the approved voice/ data and video jacks including voice/data (RJ-11, RJ-45), Video (type F, type RCA, type BNC and S-Video), Audio (type RCA) and fiber (type ST, SC, LC and MT-RJ). Faceplates and jacks

shall be by a single manufacturer. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner. Modular mounting straps under standard outlet faceplates shall not be acceptable.

a. It shall not be acceptable to utilize standard outlet style-line faceplates with modular mounting straps for the jacks. All jacks must mount directly to modular ports within the faceplate.

b. Where standard faceplates are not available from the manufacturer for the full line of jacks designed at a particular location, the contractor shall be responsible for providing a custom punched and engraved faceplate to meet the application.

2. Outlets designated to serve wall phones shall be of a type that is designed to support a wall mounted telephone. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Color as selected by Owner.

3. Outlets to be installed in floor boxes/pole-thru to be installed in faceplates, compatible with floor box/poke-thru make/model and secured within floor box/poke-thru. The use of loose or un-mounted jacks shall not be acceptable. Where floor box/poke-thru is provided by others, coordinate during construction with floor box/poke-thru to determine specific requirements for jacks and coverplate.

4. Each and every voice/data jack shall be labeled to corresponding patch panel and port. Each and every audio/video and CATV jack shall be labeled to indicate function (audio “L” and “R”, video, CATV, etc.). Coordinate labeling scheme with Owner. Labels shall be computer generated on an adhesive media and attached to the workstation outlet. Labels applied with pens or markers will not be acceptable.

5. Provide blank inserts for all unused ports.

6. Refer to drawings for arrangement of various workstation outlets including jack types and quantities within each outlet type. All voice/data/video/audio and fiber jacks indicated in the faceplate shall be deemed included in this specification unless specifically noted otherwise.

7. Outlet faceplates shall be stainless steel. Where manufacturer does not provide a full complement of voice/data and AV modules as required by design configurations, the contractor shall be responsible for utilizing a custom punch plate including all associated costs.

2.5 TR Data Termination Equipment

A. Twisted pair modular patch panels, rack rail mounted, Cat. 5e/6 rated, 110 termination, RJ-45, multi-port (24 or 48). Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in data racks in each TR. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.

B. Twisted pair modular patch panels, rack rail mounted, Cat. 6a rated, 110 termination, RJ-45, multi-port (24 or 48) with rear cable management lacing bars for additional cable management and support.. Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in equipment racks/cabinets and ZO/CP boxes below floor as indicated on drawings. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.

C. Provide quantity of copper patch panels to accommodate complete termination of all installed copper station cables plus an additional 20 percent spare capacity.

2.6 TR Voice Termination Equipment

A. Twisted pair modular patch panels, rack mounted, Cat. 5e/6 rated, 110 termination, RJ-45, multi-port (24 or 48). Equipment to be of manufacturer and series as required by Specified Link/Channel Solution Warranty. Provide quantity of patch panels as required by quantity of data station cable. Mount panels in data racks in each TR. Each panel shall be fully loaded. Provide labeling for each connected port as coordinated with Owner.

B. Provide quantity of copper patch panels to accommodate complete termination of all installed copper station cables plus an additional 20 percent spare capacity.

C. Voice termination field – Blocks shall be used for both voice riser and station cabling. Separate blocks or rows of blocks will be used for riser cables and for station cables. Riser cable blocks shall be mounted on the left, station wire blocks will be mounted on the right in the TR. Terminate the riser cable following the standard telephone color code using the first row of pins on the left and the last row of pins on the right of the block. The riser and station cable will be fed up from the bottom of the 66 blocks standoff brackets. The 66 blocks are to be stacked no more than 4 blocks high with a 2-inch space between rows of blocks.

2.7 Station Cable Termination Assignments

A. Refer to the drawings for assignment of room station cabling to the respective TR termination equipment.

2.8 Patch Cables

A. This contract shall be responsible for providing all required patch cables to make a complete and fully functioning network. The following patch cables requirements are considered part of these specifications:

1. Data Station (copper) at Workstation – Provide a ~~nominal~~ minimum 12 feet patch cable with every workstation jack to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner, prior to ordering, by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various outlets depending upon the field conditions and the locations of the equipment which utilizes any given jack.

2. Data Station (copper) at TR – Provide a ~~nominal 7 foot~~ patch cable with every patch panel port to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner, prior to ordering, by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths at various patch panel ports depending upon the field conditions and the locations of the equipment which utilizes any given port.

3. Voice Station at Workstation – None required. Telephone handsets cables are specified under section 27 31 13.

4. Voice Station at TR – Provide a ~~nominal 7 foot~~ patch cable with every patch panel port to match the EIA/TIA channel configuration of the cabling system. Coordinate the patch cable length and color with the Owner, prior to ordering, by establishing specific color types and various cable lengths throughout the installation. The Owner may requests various lengths

at various patch panel ports depending upon the field conditions and the locations of the equipment which utilizes any given port.

PART 3 - EXECUTION

3.1 General Installation

B. Backboard mounted wiring connecting blocks shall be mounted such that the top of block is no more than 72 inches from the floor and the bottom of lowest block is no lower than 30 inches from the floor.

C. Cross connects / patch cables from voice backbone cable to voice station cables shall be furnished by this Contractor, Patch cables from data backbone and data station cable patch panels to network electronic equipment shall be furnished / provided by this Contractor,

D. Refer to drawings for quantity and arrangement of voice/data/technology outlets including jacks and cabling.

E. Make all telephone and data terminations at TR termination equipment and at each workstation outlet jack utilizing a tool appropriate for the equipment as recommended by the equipment manufacturer.

F. Coordinate color requirements for all jacks, station cables, patch panels, patch cables, etc. with Owner / Engineer. Color coding shall be consistent for all like equipment.

G. Delivery of all loose equipment which is to be turned over to Owner shall be carefully coordinated and scheduled with Owner prior to shipment.

3.2 Wiring Installation

A. Data station cable shall not exceed the EIA/TIA maximum lengths for the specified Category rating. The contractor shall be responsible for verifying adequate cable pathways to limit cable lengths prior to installation. Where existing or designed pathways do not allow for compliance to distance limitations for voice and data cabling, the contractor shall provide alternate pathway routes to the Engineer for review.

B. The drawings do not indicate specific routes for telecommunications cables. The Contractor is responsible for developing all cabling routes utilizing existing cable management pathways and systems or providing supplemental cable management pathways and systems so that all structured cabling adhere to specific codes and standards specifically developed for the installation of such cables. Where the use of existing cable management systems and pathways would cause the structured cable system to violate specific codes and standards regarding cable lengths, environments, proximity to EMI and RF noise sources, etc, the Contractor shall be responsible for developing alternative pathways and shall include all labor and material for doing so within the scope of this work.

C. In areas where there is not an installed raceway system (conduits or cable tray) and a cable support system is required, this contract shall be responsible for providing a Cable Management System. Cable management system shall provide support no more than 5 feet on center. Where cables are installed open wired through the use of cable management systems, they shall be installed such that there is a minimum sag of 4 inches for every 4 foot of horizontal run. Cable pathways shall provide the following minimum clearances (parallel or perpendicular):

1. Motors and transformers – 48 inches

2. Conduit and cable used for electrical power distribution – 12 inches

3. Fluorescent lighting – 5 inches

4. Power lines up to 2kVA – 5 inches

5. Power lines over 5kVA – 24 inches

6. Hot water/steam lines - Bare –18 inches, Insulated – 6 inches

D. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

E. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

F. Each voice and data jack shall be wired with a dedicated home run. Each voice and data jack shall be identified. The jacks shall be labeled on the faceplate. Station cables shall be labeled at TR termination point with corresponding workstation outlet jack number.

G. Voice and data cables shall be handled and installed with extreme care. Twisted pairs shall be untwisted less than .5 inch at terminations for Cat, 6A, Cat. 6. Tie wraps shall loosely hold cables; do not overtighten. Cables shall have sweeping bends and shall have a maximum bending radius at any point in the installation of not less than 4 times the outer diameter of the cable. The cable manufacturer's recommended bending radius and maximum pulling tensions shall be strictly adhered and shall not be exceeded. Failure to comply will result in the removal and replacement of affected cable at no additional cost to the Owner.

H. Voice and data horizontal station cable shall not exceed the EIA/TIA guidelines for LINK distances. The permanent LINK shall be as defined in the EIA/TIA standards as the distance from the workstation outlet jack to the TR termination equipment patch panel/cross-connect port.

I. Provide adequate cable slack at each workstation outlet and the IDF/MDF termination equipment as follows:

1. Workstation (backbox) outlet

a. 12 inches of copper cable slack.

J. Where cables are installed in conduit, the conduit system shall conform to the following:

1. No section of conduit shall be longer than 100 feet between pulling points.

2. No more than two 90 deg. Bends in a section of conduit between pulling points.

3. Pulling points/pullboxes shall not be used to change direction of the conduit pathway. Pulling points/pullboxes shall be placed "in-line" with the conduit pathway.

4. Each section of conduit shall be labeled for length, destination closet and origination closet.

5. Refer to EIA/TIA 569-A for specific conduit and pull box requirements.

K. At voice termination equipment at TR racks/backboards, voice backbone and station cables shall be terminated following the standard telephone color code unless otherwise indicated.

L. All cabling installed in underground conduit installations shall be outdoor rated cables, acceptable for use by the manufacturer in underground applications.

M. Lubricant – Utilize only lubricant specifically rated for the cable being installed.

3.3 Telecommunications Rooms

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36 inch isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Within the various telecom rooms, coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as servers and UPS units may have special mounting requirements that need additional coordination.

3.4 Grounding – Not Applicable

3.5 Programming – Not Applicable

3.6 Identification/Labeling

A. The Contractor shall be responsible for labeling all supplied communications equipment, cable, etc. in accordance with the guidelines as described herein. The end of each cable, each jack, patch panel, cross-connect and rack/backboard shall be identified and permanently recorded on 8.50 X 11 sheets attached to each rack/backboard.

B. No labeling for any system which relies on room names/numbers as part of the equipment/cable labels shall be applied until the final building signage package with approved room names/numbers has been reviewed and incorporated. Labeling done based upon bid document room names/numbers prior to approved building signage package will not be accepted and may require the contractor to revise labeling at their expense.

C. Each cable, jack cross-connect and patch panel shall be labeled at every location where they are administered per TIA/EIA-606.

D. Both ends of data and telephone system cabling shall be tagged and identified utilizing a permanent cable marking system or other system as approved by the Owner / Engineer. DYMO style labels, cloth or plastic “numbers” or hand written labels WILL NOT BE ACCEPTED.

E. Station Cable, Room side - Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “TR5-01-33” (read as: Station cable, fed from TR-05, terminated in patch panel 01, terminated on jack number thirty three).

2. First syllable shall consist of a numeral following the letters “TR”. The numeral shall indicate the wiring closet “TR”, the jack and cable feed from (2 would be “TR-02”, 7 would be “TR-07”, etc.).

3. The second syllable shall consist of a numeral. The numeral shall indicate which patch panel in the wiring closet the cable is connected to.

4. The third syllable shall consist of a numeral to indicate which jack in the patch panel the cable is connected to.

5. Labels to be applied within 6 inches of termination.

F. Station Cable, Closet side - Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “143-01-33” (read as: Station cable, located in room 143, terminated in patch panel 01, terminated on jack number thirty three).

2. First syllable shall consist of a numeral. The numeral shall indicate the architectural room number of the room the jack is located in.

3. The second syllable shall consist of a numeral. The numeral shall indicate which patch panel in the wiring closet the cable is connected to.

4. The third syllable shall consist of a numeral to indicate which jack in the patch panel the cable is connected to.

5. Labels to be applied within 6 inches of termination.

G. Utilize a three (3) syllable labeling scheme as follows:

1. Sample label for station cable / jack “S3-D3-05” (read as: Station cable, fed from IDF 3 - terminated in the data rack on the third patch panel - jack number five).

2. First syllable shall consist of a letter and a numeral. The letter shall be “S” indicating “station cable”. The numeral shall indicate the wiring closet “IDF”, the jack and cable feed from (IDF 2 would be “2”, IDF 7 would be “7”, etc.).

3. The second syllable shall consist of a letter and a numeral. The letter shall indicate the type of rack/frame the cable is fed from (“D” - Data, “T” - Telephone). The numeral shall indicate which patch panel in the rack (for data) or BIX cross-connect (for telephone) the cable is connected to.

4. The third syllable shall consist of a numeral (starting at 01) to indicate which jack in the patch panel (for data) or which wiring pair group in the cross-connect (for telephone) the cable is connected to.

H. Each communications faceplate will be numbered with a 4-digit number for each installed jack as follows:

1. The first digit will represent the floor the outlet is located on. 0 for ground floor or basement, 1 for first floor, 2 for second floor, etc.

2. The second number will consist of 3 digits and will represent a sequential number from 001 to 999. The number will start at 001 if there is only one TR serving that floor. Where multiple TR closets are located on that floor, each closet will be assigned a group of 250 numbers and outlets from each TR will be numbered sequentially. TR #1 would be 001 through 250. TR #2 would be 251-500, etc.

3. All voice jacks will have odd numbers only and all data jacks will have even numbers only.

4. Data patch panels and voice punch down blocks must provide corresponding numbering. All voice blocks will be numbered from top to bottom, left to right.

I. Patch panels to have panel # / port # / room number for each terminated cable.

J. This contractor shall be responsible for creating/maintaining the numbering scheme as directed by the Owner.

K. Create a detailed records sheet for the station cabling including floor plans showing outlet locations and which jacks are in which outlet. Records shall indicate connection rack/backboard, patch panel / cross-connect and jack / port, at both ends, for each cable. Provide with O&M Manual

L. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 Testing General

A. The Contractor shall be responsible for testing all installed structured cables including:

1. Voice and data station

B. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted. All final test reports shall utilize the field installed labels at each outlet for the test of the corresponding outlet. Test reports which contain temporary generic or incorrect labels will not be accepted.

C. No testing shall be executed until the entire system has had the Owner approved labeling scheme applied and accepted.

D. Tests shall be witnessed by Architect / Engineer / Owner and shall be monitored by a recorder.

E. System testing shall be performed with final test results turned over to the Owner prior to acceptance of the system. Missing or incomplete test results will not be reviewed and the system will not be commissioned by the Owner / Architect / Engineer.

F. Instruments and labor required for tests shall be furnished by the Contractor. All system test equipment shall be approved by the Owner/ Architect / Engineer prior to application.

G. The Owner / Architect / Engineer reserve the right to spot test 5 percent of the installed cabling plant to verify documented test results. Where the Owner / Architect / Engineer have determined that the installed cable plant does not agree with the documented test results, the contractor shall be responsible for re-testing the installed voice/data/fiber cabling plant and revising/updating all test documentation as required.

H. Instruments required for tests shall be furnished by the Contractor.

3.8 Testing Voice/Data Station

A. Each user voice and data station cable system shall be electronically verified. The voice / data system shall be tested in the permanent LINK (from the workstation outlet jack to the termination equipment patch panel port/cross-connect port) configuration. Each voice and data permanent LINK shall meet or exceed the EIA / TIA Solution Manufacturer's specified parameters of components within each permanent LINK. The respondent's test plan will specify the procedures for the following tests:

1. Wire Map - A continuity test to determine correct 568A/B eight position pin-out. The test inherently verifies correct circuit identification.

2. Length - Each cable pair is TDR scanned to determine each pair's individual length. The test results are recorded in feet. The EIA/TIA specification limit of 90 meters is used to qualify the overall length of each circuit.

3. Attenuation - This test measures the loss or attenuation that each pair exhibits to determine whether or not high speed data packets will be discernible at their destination.

4. Induced Noise - The noise test measures the presence of external signals at three critical frequency ranges. The test results of each pair are recorded. The three ranges to be tested are as follows:

   a. Low Band (10Hz-150 Khz)

   b. Mid Band (150 Khz-16 Mhz)

   c. High Band (16 Mhz-100 Mhz)

5. Resistance - a) Loop resistance, pair balance, pair-to-pair unbalance

6. Near End Crosstalk (NEXT) - The NEXT of each pair is measured as impacted by every other possible pair combination. The test sweeps the specification bandwidth to determine the worst case NEXT frequency for a particular pair. Both the NEXT value and occurring frequency are documented for each possible pair combination. The order of testing is as follows:

   a. Pair 1 & 2 to Pair 3 & 6

   b. Pair 1 & 2 to Pair 4 & 5

   c. Pair 1 & 2 to Pair 7 & 8

   d. Pair 3 & 6 to Pair 4 & 5

   e. Pair 3 & 6 to Pair 7 & 8

   f. Pair 4 & 5 to Pair 7 & 8

7. Test for Return Loss, Delay, Delay Skew, NEXT, PSNEXT, ELFEXT, PSELFEXT, ACR and PSACR shall be as required by the latest edition of EIA / TIA Level III tests and the latest edition of the Manufacturer's/Source's Channel Solution Program to verify adherence to these specifications of the cabling system.

8. All tests shall pass without any “marginals”.

B. Provide a hard copy of the test results of each and every voice and data channel tested to the Owner. Documentation shall be in the following format:

1. Cable ID

2. Test parameter used

3. Date of test

4. Length

5. Pass / Fail result

6. Provide an electronic copy of the LINK/CHANNEL testing done with a cable analyzer and saved on removable media. Test results saved in a proprietary file type shall be included with software for reading the test results on the Owner’s computer system. Test results shall be verified by the Owner as part of the acceptance procedure. Provide with hard copies and a removable media containing the electronic files with the O&M Manuals.

3.9 Coordination With Communications Service Providers – Not Applicable

3.10 Training Requirements – Not Applicable

3.11 System Acceptance Requirements

A. The contractor shall submit printed test results per the testing specification requirements for review by the Engineer/Owner prior to system acceptance. Any cable components that have not passed the full requirements of the system testing shall be replaced and re-tested at the contractor’s expense prior to system acceptance.

3.12 As-Built Documentation

A. Refer to Section 27 05 01 for submittal requirements.

C. Copies of all approved shop drawings with the Engineer’s stamp.

D. Owner’s manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner’s manuals. CDs containing electronic versions of Owner’s manuals must contain the proper software viewers for each document type.

1. Termination cabinets, panels and enclosures

E. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

1. AutoCAD architectural floor plans at a scale of 0.125 inches =1 foot-0 inches on 30x42 size sheets showing the location and label of each workstation outlet, IDF closet and MDF

closet. Labeling shall match the labeling installed in the field. These drawings shall be as-built conditions.

2. AutoCAD architectural floor plans at a scale of 0.25 inches =1 foot-0 inches on 30x42, 24x36 size sheets showing the telecommunications equipment layout in each IDF closet and the MDF closet. This layout shall include the racks, backboards, cable tray, conduit sleeves, 120V power, etc. Each piece of equipment where labeled in the field shall have the corresponding label on these plans. These drawings shall be as-built conditions.

3. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

4. Rack elevations for all systems with rack mounted equipment. The details shall indicate each piece of telecommunications equipment in each rack including equipment labels such as patch panel, wire management panel, blank panel, space, etc. Each port of each patch panel shall be fully labeled to match the labeling installed in the field.

F. Cable Test Results - Provide bound documents of all cable test results in printed format and in software version on a compact disc. Software version must include any required reader software where file formats are proprietary or non-standard text files. Cable test results shall be organized by media (fiber, copper) and by closet. Information must be included in O&M Manuals.

1. Copper Test Results

a. Documentation shall be in the following format:

1) Cable ID

2) Test parameter used

3) Date of test

4) Length

5) Pass / Fail result

G. Create a detailed records sheet for the station cabling including floor plans showing outlet locations and which jacks are in which outlet. Records shall indicate connection rack/backboard, patch panel / cross-connect and jack / port, at both ends, for each cable. Provide with O&M Manual.

H. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials as described herein. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

3.13 Warranty

A. The entire structured cabling system as specified herein shall be guaranteed against defects in workmanship and materials. Period shall commence after system has been commissioned by the Owner, Engineer and Architect. The Installing Contractor shall provide the initial warranty service. The extended warranty shall be provided by the manufacturer. Provide a written statement of this warranty as part of the shop drawing submittal and included in the O&M Manuals.

I. The entire voice / data station cabling system warranty shall be a listed cabling system solution from a single Manufacturer / Source. The system shall carry an industry standard, performance based warranty, by the manufacturer, for a period of at least 20 years on the horizontal cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of three (3) years from date of substantial completion.

J. The warranty shall not be affected by the use of power over Ethernet on any or all of the links.

K. The warranty shall not be affected by selected links required to have transition points from OSP to indoor where serving underground conduits to floor boxes. It shall be the Contractors responsibility to provide manufacturer's approved transition points to maintain system warranty on any affected runs.

3.14 Certification

A. The contractor shall be responsible for filing all required paperwork on behalf of the Owner to acquire the system performance warranty and certification as outlined in the Structured Cabling System Solution.

END OF SECTION

28 13 00 PHYSICAL ACCESS CONTROL (PACS)

PART 1 - GENERAL

1.1 Scope of Work

A. These specifications shall be utilized for the complete system as specified herein and as shown on the bid documents

1.2 Scope of Work

A. Provide an expansion of an existing Physical Access Control System (PACS) which fully integrates all the functions and features specified herein for electronic access control. The existing system is Genentec

B. These specifications contained herein describe specific functional requirements of the PACS as required by the Owner. It is the intent of these specifications to detail and describe the performance of the system. The system features outlined in the specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

1.3 System Description

A. The PACS shall be a n expansion of Electronic access control system providing local, remote and Time Of Day control of doors/portals/entries/elevators as indicated on the drawings and as specified herein.

B. System shall be configured for a single site.

C. The following main components are considered part of the project:

1. Credentials and Credential Readers

2. Access Control Module

a. Field installed controllers, Power supplies, Sensors, Cabling

D. System Cabling and pathways.

E. System programming a total system sequence of operation for the system.

1.4 Quality Assurance

A. All system components shall be UL listed.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes. The system shall be in compliance withal FCC Rules and Regulations.

C. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.

D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

E. To establish continuity in the manufacturer, systems components shall be the standard product of one manufacturer. Further, an effort shall be made to establish common sources for equipment of all systems. The manufacturer will have a minimum of five (5) years' experience in the manufacture of progressive products specified.

F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

G. All material furnished under this contract shall meet or exceed minimum performance and operational requirements as established by the system vendors for the configurations being implemented for this project.

1.5 Contractor Qualifications

A. The PACS shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the PACS contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified PACS. This experience shall include having completed a minimum of 2 installations in the past 24 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.6 Shop Drawings – The submittals shall consist of the following information:

A. Job specific system block diagram indicating the actual hardware required for the project including part numbers and interconnecting wiring requirements.

B. Complete and comprehensive Equipment Catalog Specification Sheets of each component provided, job specific.

C. 30x42 floor plans at a scale of not less than 1/8 inches=1 feet-0 inches showing location of all items of equipment. Drawings shall also indicate each location where 120 power is required.

D. Submittals that do not contain all the above information will be rejected.

PART 2 - PRODUCTS

2.1 Product Equivalency

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals **if all specified features are provided**. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the “precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor’s expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

C. This specification is intended to establish a carefully planned minimum level of quality and performance for all components, and will be rigorously enforced by Owner. Acceptable manufacturer of components described herein are:

1. Genetec

D. The PACS shall be a regularly manufactured system offered by a single manufacturer/source as an integrated system.

E. Contractors shall submit reference letter with information regarding current installations utilizing the listed manufacturer pairings along with contact information at each installation site. Reference letter shall include brief summary of system scope for both CCTV and PACS and level of integration being utilized.

F. Final approval of systems listed above shall be at the discretion of the owner/engineer pending review of system reference information and back-up documentation. Upon request by Owner/Engineer, contractor and/or manufacturer may provide on-site product demonstration to validate system ability to meet specified level of integration.

2.2 Credential Readers

A. Credential readers shall comply with OSDP standards

B. Credential readers shall comply with FIPS 2.0 standards

C. Read Technology

1. Read method – Contact

D. Form Factor

1. Mullion – Coordinate with door frame for mounting and cabling access.

2. Pedestal/Post - Provide standard/custom/surface mount box as required by system manufacturer and post/pedestal manufacturer.

2.3 Access Control Module

A. Data Gathering Panels (DGP) Field Controllers

1. Centralized Controllers

a. Central Control Panel(s) shall consist of network communications via Ethernet based IP loop and shall contain all electronics and on-board memory to provide

interface with PACS servers and centralized/remote door controllers.. The panel(s) shall provide access control, alarm monitoring, and time zone control for both access and egress of selected areas. The panel shall have the capability for system expansion.

2. Edge Controllers

   a. Door Control Panel(s) shall consist of network communications via Ethernet based IP loop and shall contain all electronics and on-board memory to provide 1 or 2 door access and interface with card readers, door position sensors, electronic door hardware, auxiliary I/O points, and the local fire alarm system in the event of loss of server communications. The panel(s) shall provide access control, alarm monitoring, and time zone control for both access and egress of selected areas. Panels shall support IP and PoE+ for panel connectivity and power.

3. Door Controllers

   a. Door control panels shall include IP based communications portals to Central Controllers/PACS servers. Panels shall provide multiple door control (2, 4, or 8) per board with Reader/REX/Contact and 2 alarm relays per door. The controller utilizes a locally stored database so that it continues to operate without the presence of the Central Controller, making all access decisions and recording all transactions.

4. Input/Output Modules

   a. I/O control panels shall include IP/Bus based communications portals to Central Controllers/Door Controllers. Panels shall provide multiple I/O relays (8, 16, or 24) per board with 30V/3A rated relays.

5. Panel Hardware

   a. Provide wall mounted, lockable panel tubs with tamper switch for all equipment.

   b. Provide required power supplies with additional battery back-up for minimum 1 hour standby power.

   c. All cabling within panels to be organized and managed and fully labeled.

B. Door position sensors

   1. Balanced Magnetic position switch – Refer to Door Control Schedule for application at each controlled portal.

   2. Mounting - Refer to Door Control Schedule for application at each controlled portal.

   3. Utilize sensors to provide door position status during occupied hours as required by Owner’s programming and alarm points when so programmed or required by the Owner’s sequence of operation.

C. Request to Exit

   1. Devices (alarm shunt) –

a. Motion detector – Provide wall/ceiling PIR motion detector with beam detection for door threshold. REX motion detectors to provide alarm free exit of monitored doors during system operation. REX device shall be installed, powered, wired and programmed as part of this contract.

b. Door Hardware - REX switch to be integral with door hardware. REX device to provide alarm free exit of monitored doors during system operation. REX devices shall be wired and programmed as part of this contract.

2. Devices (door unlock) –

a. Motion detector – Provide wall/ceiling PIR motion detector with beam detection for door threshold. REX motion detectors to provide alarm free exit and unlock of monitored doors during system operation. REX device shall be installed, powered, wired and programmed as part of this contract.

b. Door Hardware - REX switch to be integral with door hardware. REX device to provide alarm free exit and door unlock of monitored doors during system operation. REX devices shall be wired and programmed as part of this contract.

c. Wall switch – REX switch to be wall mount button stations to provide alarm free exit and door unlock of monitored doors during system operation. REX devices shall be installed, powered, wired and programmed as part of this contract.

D. Electronic door hardware

1. Refer to Specification DIVISON 08 for electronic door hardware.

2. Electronic door hardware with operating power supplies are supplied by the DIVISON 08 Contract with wiring pig tails.

3. Electronic hardware is being installed in the door frames (locks, hinges, power transfers) by DIVISON 08. This contract shall be responsible for low voltage door hardware power supplies, connecting all low voltage wiring from door hardware and power supplies to the access control system for a complete, functional and operating system.

4. Low voltage power, wiring and controls to electronic door hardware to remotely lock/unlock selected doors in real time via the software GUI, through local credential readers, through TOD schedules, interface with intercom system, or remote push button devices. System shall provide the Owner with the ability to remotely control doors from the remote access workstations, head end server, associated credential readers, request-to-exit devices, intercom system, local push button release, and the fire alarm system.

E. Power Supplies

1. PACS Equipment

a. Power supply/chargers with 115VAC, 60Hz input, fused four (4) protected outputs. Outputs are selectable for 12VDC with a total of 4A max. or 24VDC with a total of 3A max

b. Supervision

1) AC Failure Form “C” contacts

2) Battery Form “C” contacts

3) Indicators (LED)

a) Input 115VAC is present

b) DC Output Powered

c) Battery Discharged or not connected

c. Back-up Battery

1) Capacity: Sized to provide operational power for a minimum of twelve (12) hours).

2) Type Sealed lead acid/gel type/Lithium Ion.

3) Fuse Rating 15A @ 32VDC

4) Failover Upon AC loss, instantaneous

d. Listings

1) UL294 Access Control System Units

2) UL603 Power Supplies for Use with Burglar-Alarms Systems

3) UL 1069 UL Listed Hospital Signaling and Nurse Call Equipment

4) UL1481 Power Supplies for Fire Protective Signaling System

2. Door Hardware

a. Input Voltage: 12 to 24 VAC or VDC operation, 0.6A @ 12V, 0.3A @ 24V current consumption with all relays energized. Main fuse is rated at 10A/250V

b. Trigger Inputs: Eight (8) Access Control System trigger inputs:

1) Eight (8) normally open (NO) inputs

2) Eight (8) open collector sink inputs

3) Any combination of the above

c. Input Options:

1) One (1) common power input (board and lock power)

2) Two (2) isolated power inputs (one (1) for board power and one (1) for lock/accessory power)

3) Fire Alarm input.

d. Outputs

1) Eight (8) independently controlled 2.5A outputs:

a) Eight (8) Fail-Safe and/or Fail-Secure power outputs (field selectable)

b) Eight (8) dry form “C” 5A rated relay outputs.

c) Any combination of the above

d) Eight (8) auxiliary power outputs (unswitched)

e. Output ratings: Output fuses are rated 3.5A/250V each

f. Indicators (LED)

1) Red LEDs Outputs are triggered (relays energized)

2) Green LED FACP disconnect is triggered

g. Battery Back-up

1) Provide 1000VA, line interactive UPS, connected to panel power supply to fully power locks during normal power failure.

2) Provide UPS with floor mount hardware.

h. Listings

1) UL294 Access Control

3. Non-Card Reader Controlled Doors

a. Provide interface with delayed egress to allow temporary override (alarm and unlock) at the secure side of the door via the keypad.

4. Provide connection and wiring from control stations to each delayed egress door to provide annunciation of door (armed/disarmed) and open/closed. Provide push-button temporary override of delayed egress (alarm and unlock) via the control station.

5. Provide fire alarm interface to unlock delayed egress doors upon fire alarm.

6. Provide full access control system monitoring of door position.

2.4 Wire and Cable

A. Contractor shall include all necessary wire, cable and accessories for a complete working system.

B. Utilize cable types as recommended by the system/equipment manufacturer.

C. All cabling to be plenum rated when installed open wired.

D. The following cable types at a minimum are required:

1. Lock Power
2. REX monitoring
3. Latch bolt monitoring
4. Door Position switch monitoring
5. Credential Reader

E. The use of “composite” Access Control cabling consisting of multiple cable types manufactured under a single jacket shall NOT be allowed.

F. Cabling scope shall include connections to any device “pigtails” provided with the PACS end device.

PART 3 - INSTALLATION

3.1 General Installation

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation.

C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Devices such as motion detectors, audio detectors, glass break sensors, etc. shall be installed following the manufacturer’s recommendations.

D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer’s and Owner approval. A CSR of the installing contractor or manufacturer shall train the Owner’s personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

3.2 Wiring Installation

A. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the PACS wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site.

B. Where pathways do not exist for PACS wiring, this contract shall be responsible for providing all required cable management systems such as sleeves, conduits, J-hooks, etc. to support communications cabling to meet building codes and manufacturer’s recommendations.

C. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

D. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

E. The PACS contractor shall be responsible for interconnection and signaling including all wiring and terminations at both ends for the following auxiliary systems

3.3 Telecommunications Rooms

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the Owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

3.4 Grounding

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

C. The Division 26 Contractor has provided 120V branch circuitry for use by the PACS system contractor. The branch circuitry is run with a dedicated equipment grounding conductor which shall be utilized by the PACS system equipment. In no case shall the PACS system installation compromise the integrity of the Building Electrical Grounding System.

3.5 Programming

A. It is the Contractor’s responsibility to program the system in this section according to the Owner’s wishes. Programming may include some of all of the following elements:

1. Users/Accounts
2. Credential Holders
3. Door Groups
4. Access Groups
5. System Partitions
6. Time of Day schedules
7. Graphical Maps
8. User Interface Customization

B. The contractor shall provide to the Engineer an information request form indicating what information and data fields will be required to be provided by the owner for system programming.

C. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval.

D. After approval is granted, proceed with final programming. The programming shall include the following at a minimum:

1. Creation of door and elevator access groups. Assigning door and elevator access groups to credential holders.

2. Creation of alarm codes in all buildings for all staff including building and zone privileges for each code.

3. Creation of multiple Time Of Day schedules for all controlled doors, alarm devices and security zones to account for various modes of operation in all buildings.

4. Creation of security zones within each building including assigning associated alarm devices to respective zones and creation of arm/disarm codes for each zone.

5. Software interface with CCTV system for camera icons on the Graphical floor plans, TOD operations and alarm modes.

6. Software interface with FA system for release of door hold opens and for release of door locks on fire alarm

7. Software interface with Door Intercom System.

8. Software interface with building paging system to initiate pre-alarm all-call.

3.6 Identification/Labeling

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 Testing

A. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification. Original copies of all data produced during performance verification shall be turned over to the Owner at the conclusion of testing prior to final approval.

B. The field testing shall demonstrate the following as a minimum:

1. Proper activation and restriction at all PACS controlled portals/Elevators

2. Graphical maps fully populated with required and functional interactive icons

3. System management and reporting modules customized and operational per the Owner’s requirements.

4. Proper activation of all alarm points

5. Proper activation of all Intercom controlled doors

C. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Owner that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

D. Performance Verification Test: The Contractor shall demonstrate that the completed PACS complies with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Owner may terminate testing at any time when the system fails to perform as specified.

3.8 System Start-Up Requirements

A. The equipment supplier shall provide system integration, set-up and start-up assistance to the Installing Contractor. The proposal shall include complete technical on-site assistance for these activities as required for this system’s size and complexity. After completion of the installation, the supplier shall commission the system and request an initial acceptance test by the Owner and Engineer. A final acceptance test shall then be scheduled after correcting any system deficiencies or functionality issues that are determined in the initial test. Provide training, by a system certified trainer, at the project site as coordinated with the Owner and Engineer. The training shall include the following elements:

1. Start-up shall include a complete working demonstration of the PACS.
2. Demonstrate purpose, adjustment, operation and maintenance of the system including each component and control.
3. Review binder containing instructions and equipment and systems data.
4. Technical training sessions, which shall include hands-on training, accompanied by full system documentation and system as-built drawings.
5. Training shall include any documentation and hands-on exercises necessary to enable operations personnel to assume full operating responsibility for the PACS after completion of the training period.
6. Provide a manufacturer’s “Certificate of Completion” that is signed, dated and documented for each trainee.
7. The PACS manufacturer shall have available technical support for the Owner.

B. Division 28 Contractor shall have the total single point of contact responsibility for all aspects of the PACS implementation, including equipment supply, integration, customization, start-up and on-going systems support.

C. Division 28 Contractor shall employ a service technician to the area that is specially trained and certified to modify and repair the PACS system and who specializes in PACS and Security system integration.

3.9 Training Requirements

A. Provide the Owner with a minimum of 24 hours of training for the PACS system, and an additional 24 hours of training for personnel designed to make all users familiar with the full and complete operation of the system. **All training shall be executed by factory trained and certified personnel**. Provide documentation of qualifications prior to training.

B. The training periods shall be scheduled with the Owner after the successful completion of the system. Training on a demonstration system will not be accepted.

C. Training shall be provided to cover three general classes of users

1. Monitoring/control only end user – This user should be able to access the system for monitoring and control of local equipment only. Provide this level at each building.
2. Local Administrator end user – This user should be able to perform all functions of the monitoring/control end user and be able to perform local programming features such as TOD schedule changes. Provide this level at each building.
3. Administrator end user – This user should be able to perform all functions of the Local Administrator end user and be able to perform all global programming, maintenance, reporting, database management, etc. to be fully capable of managing all aspects of system operation. Provide this level at the NOC only.

D. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

E. Training shall include multiple four-hour sessions encompassing all instructions required for system operation. Provide operators manuals and user guides with training. Provide follow up training after initial training.

F. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

G. Demonstrate adjustment, operation and maintenance of the system including each component and control.

3.10 System Acceptance Requirements

A. The contractor shall demonstrate proper operation of all aspects of the system to the Owner's representative.

3.11 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect or Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M Manuals.

B. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period. Provide estimated cost of this service contract within the proposal.

C. Contractor shall be responsible to provide service during normal working hours within (8) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of any system component inhibiting access to the system operation, or the loss of the main server.

D. If equipment cannot be repaired with 24 hours of service visit, the Contractor shall provide "loaner" equipment to the Owner at no charge.

E. Proper identification is required and must be visible while on-site for warranty/service calls. Provide notification of completion to the Owner prior to departing the site.

3.12 O&M Manuals

A. Copies of all approved shop drawings with the Engineer's stamp.

B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of Owner's manuals must contain the proper software viewers for each document type.

C. Technology drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. Warranty: Provide statement of warranty with O&M manuals.

END OF SECTION

28 23 01 VIDEO SURVEILLANCE - IP

PART 1 - GENERAL

1.1 General

A. These specifications shall be utilized for the complete system as specified herein and as shown on the bid documents.

1.2 Scope of Work

A. These Specifications contained herein describe specific functional requirements of the CCTV system. It is not the intent of these specifications to detail and describe the exact performance of the system. The system features outlined in the Specifications are deemed mandatory for the project. References to model numbers are intended only for descriptive purposes. Systems that deviate from these Performance Specifications shall be considered alternate systems.

B. IP based video surveillance supporting a single building/single site, multiple buildings/single site, multiple buildings/multiple sites.

C. Interior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, features, etc. throughout the building interior as indicated on the drawings and as specified herein.

D. Exterior Camera System - System consists of multiple IP based cameras with specified housings, mounting, lenses, local power supplies, features, etc. around the perimeter of the building as indicated on the drawings and as specified herein.

E. Network Camera Cabling

1. Data/Video Provided under section 27 15 13

1.3 Quality Assurance

A. All system components shall be UL listed.

B. Installation shall be in compliance with the National Electric Code and all other applicable codes. The system shall be in compliance withal FCC Rules and Regulations.

C. All equipment described herein shall be the product of a manufacturer of established reputation and experience, who shall have produced similar equipment for a period of at least 2 years and who shall be able to refer to similar installations within a 75 mile radius now rendering satisfactory service.

D. The manufacturer and their local agent shall show satisfactory evidence upon request that they maintain a fully equipped service center capable of furnishing adequate inspection and service to the equipment including standard replacement parts. The manufacturer and /or agent shall be prepared to offer a service contract for the maintenance of the system after the warranty period.

E. To establish continuity in the manufacturer, like systems components (e.g. all cameras) shall be the standard product of one manufacturer. The manufacturer will have a minimum of two (2) years' experience in the manufacture of products specified.

F. All materials furnished under this contract shall be new, of highest quality and shall be of a regularly manufactured line, currently in production at the time of installation.

G. All material furnished under this contract shall meet or exceed minimum performance and operational requirements as established by the system vendors for the configurations being implemented for this project.

1.4 Contractor Qualifications

A. The Closed Circuit Television System shall be furnished, installed and programmed by a contractor who meets all the requirements listed herein. It shall not be acceptable for the CCTV contractor to utilize a sub-contractor for any portion of the work, unless the sub-contractor has been approved in writing by the Engineer based upon adherence to the qualifications listed herein.

B. The Contractor shall maintain a fully equipped, factory certified service organization capable of providing full maintenance and service of the installed system within 24 hours. This facility shall be available for inspection by the Engineer.

C. The Contractor shall employ factory trained service personnel for the service and maintenance of the system.

D. The Contractor shall have had a minimum of 1 year experience with the specified CCTV system. This experience shall include having completed a minimum of 2 installations in the past 12 months of similar size and scope. The Contractor shall provide references and contact information for the project sites in which the qualifying installations occurred.

1.5 Shop Drawings - Submit shop drawings including product data sheets and wiring diagrams per requirements in the General Conditions including the following:

A. A complete list of materials with model and part numbers and references to the Part 2 specification paragraph numbers.

B. Manufacturers Data Sheets of all products and cabling, specific to the project. Data sheets shall show the exact parts, with model numbers and options as required and clearly identified.

C. Qualifications

1. A statement of contractor’s qualifications to verify compliance with other provisions within the specifications, unless the contractor has been pre-approved.

D. Job specific wiring diagrams.

1. This indicates a block diagram that shows all major items of equipment required for the contract project and the actual interconnection that will be installed.

E. Supplier shall provide rack elevations showing the configuration of all rack mounted equipment including detailed interconnection diagrams between equipment

F. 30x42 floor plans at a scale of not less than 1/8 inch =1 foot-0 inches showing the location of all items of equipment. Drawings shall also indicate each location where electrical power is required, and the specific configuration of that power connection (voltage, plug type, mounting height, etc.)

G. Software data – The data package shall consist of manufacturer's data sheets of all system and application software being provided with sufficient information to verify that all specified features and functions are being addressed.

H. Submittals that do not contain all the required information will be REJECTED unless prior approval for partial submittals has been approved.

PART 2 - PRODUCTS

2.1 Product Equivalency

A. Where products are listed with multiple manufacturers, these manufacturers will be approved as equals if all specified features are provided. Any equipment not specifically approved in writing prior to the bid date will not be considered regardless of qualifications. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate equipment at the Contractor's expense.

B. Different manufacturers may require various options, accessories, converters, patch cables, etc. to perform the specified features and functions. Therefore, all material and/or equipment necessary for proper operation of the system shall be deemed part of these specifications.

C. This specification is intended to establish a carefully planned minimum level of quality and performance for all components, and will be rigorously enforced by Owner. Acceptable manufacturers of components described herein are listed within the specific product section.

2.2 Cameras

A. The following sub-paragraphs define the basic camera/lens/housing types and minimum performance specifications that must be met by the selected products. The contract documents indicate which of these features/functions/housings/etc. must be included with each specific camera.

B. IP based, IPv6 compliant, Cameras shall be Open Network Video Interface Forum (ONVIF) compliant:
   1. Profile S – For streaming video, Streaming and Configuration
   2. Profile C - For IP-based basic access control, Site information and configuration, Event and alarm management, , Door access control.
   3. Profile G - For edge storage and retrieval, Configure, request and control recording, Receive audio and metadata stream.
   4. Profile Q - For quick installation, Easy setup, Discovery, configuration and control of conformant devices
   5. Profile A -For broader access control configuration, Granting/revoking credentials, Creating schedules, Assigning access rules.
   6. Profile T -For advanced video streaming, H.264 / H.265 video compression, Imaging settings, Motion alarm and tampering events.

C. Camera shall have removable media storage provisions comprised of purpose built minimum micro SDHC/SDXC cards slots that have been optimized for 24/7 video storage and retrieval with ext4 file system, 20MBs read/write speed, up to 128GB capacity.

D. Environment

   1. Exterior Domes – Housing shall be IP66/IP67 rated.
   2. Interior Domes – Housings shall be heavy duty and shall utilize smoked polycarbonate domes. Unless otherwise noted, all interior cameras shall be unitized domes.

3. Vandal Resistant – Housings shall utilize all vandal/tamper resistant hardware and impact resistant polycarbonate domes.

E. Mounting

1. Surface – Wall. Unit shall mount on directly on wall surface/utilizing a wall mounted arm to a recessed electrical outlet box as indicated on the drawings.
2. Surface - Ceiling. Unit shall mount on surface of ceiling to either an electrical outlet box or directly on the ceiling surface as indicated on the drawings.
3. Recessed – Ceiling. Unit shall mount recessed in an accessible ceiling via the use of ceiling grid support hardware or shall be recessed directly into a fixed ceiling system with appropriate hardware.

F. Imager/Resolution (refer to camera schedule for specific minimum resolution requirements for each camera)
1. Unit shall include a single megapixel imager with the following minimum specifications:
   a. 1MP – 1/3”, 1280x720, 30fps
   b. 2MP – 1/2.8”, 1920x1080/1920x1200, 30fps
   c. 3MP – 1/3”, 2048x1536, 30fps
   d. 4MP – 1/2.8”, 2688/1520, 20fps
   e. 5MP – 1/3”, 2592x1944, 12fps
   f. 6MP – 1/1.8”, 3072x2048, 12fps
   g. 4K (UHD) – 1/2.5”, 3480x2160, 15fps
   h. 12MP – 1/1.7”, 4000x3000, 12fps
2. Imager shall be color progressive scan.
3. Sensitivity
   a. Standard – 0.8
   b. Low Light Option - 0.15 (color)/0.03 (B/W)
4. Dynamic Range
   a. Standard – minimum 60dB
   b. Wide Dynamic Range Option (true WDR, not digital WDR) – Camera to utilize electronic shutter combined with taking multiple images at various shutter settings. The camera shall then re-combine the images utilizing an algorithm to provide enhanced dynamic range via on-board DSP. Minimum 120dB.
5. Camera shall utilize Electronic shutter, dynamic backlight compensation, automatic gain control, automatic White balance.

G. CODEC
1. Compression
   a. Up to 8MP - MJPEG, H.264.
   b. 4K and above - MJPEG, H.264, H.265, proprietary dynamic compression.
2. Streams – Minimum 3 streams, each at full resolution.

H. Lens

1. Refer to drawings for specific lens requirements for each camera.
2. Vari-focal – Lens to be high resolution, Aspherical, multicoated with adjustable zoom, focus and iris. Focal length range as specified on drawings
3. Mega-pixel – Lens to be mega-pixel compatible, hybrid aspherical maintaining image resolution from center to edge, multicoated with adjustable zoom, focus and iris. Lens resolution rating shall be matched to camera resolution.
4. All cameras shall utilize a motorized lens for zoom/auto/back focus.
5. All cameras shall utilize a automatic control for F-stop/depth of field control.

I. Enhanced Features – Refer to drawings and camera schedule for additional special feature requirements such as Low Light Sensitivity, Wide Dynamic Range, PTZ, and Day/Night.

1. Wide Dynamic Range – Camera to utilize electronic shutter combined with taking multiple images at various shutter settings. The camera shall then re-combine the images utilizing an algorithm to provide enhanced dynamic range via on-board DSP.
2. Low Light – Light Sensitivity 0.1 lux at f1.3 or better.
3. Day/Night – The camera shall utilize a true (not digitally synthesized) low light operation which switches the camera from color to B/W mode by removing the IR cut filter. Low light sensitivity shall be increased in night mode to 0.06lux minimum. D/N feature shall be automatic and not switched manually. Camera to utilize enhanced day/night lens (IR corrected) and imager to prevent focus issues when the IR cut filter is removed. Camera to also utilize automatic back-focus.
4. Pan/Tilt/Zoom – Camera shall utilize highly reliable, heavy duty rated mechanism for true 360deg panning, 0-90deg tilt with minimum 1deg/s and max 300deg/s pan and tilt speeds. Zoom lens shall be as indicated on drawings. Camera to be fully programmable including home position minimum 25 presets, and tours. Unless otherwise noted, all PTZ cameras to be incorporated in unitized domes (autodomes).
5. Analytics – Real time video analytics which provide basic processing for events such as virtual trigger, abandoned objects, perimeter breaches, loitering, and object removal.
6. IR Illuminator – Camera shall include 25/50 IR LED illuminators with practical range of 30/60/100ft. Cameras with integral IR shall utilize an IR “shield” coating to prevent internal reflections of IR on dusty or dirty dome housings.
7. Panoramic – Camera shall utilize multiple megapixel imagers to produce a 180deg/360deg panoramic field of view.
8. Manufacturer specific dynamic compression.

J. Connectivity

1. IP Cameras – Camera to utilize integral NIC for 100MBs minimum Ethernet connection.

K. Power

1. IP - Interior cameras to utilize IEEE 802.3af Power over Ethernet (PoE).
2. All exterior cameras to be provided with surge arrestors on the power/signaling cabling.

L. Manufacturers - The following list of manufacturers are considered approved for use provided the individual camera selections conform at a minimum to the above listed specifications –Axis,
1. Panoramic – Axis.

2.3 CCTV Data/Video Cabling

A. Refer to section 27 15 13 Communications Copper Horizontal Cabling.

2.4 Low Voltage Camera Power Supplies – The following power supplies are listed for use. It shall be the contractor’s responsibility to provide all operating power for all cameras regardless of voltage, current and distance requirements.

A. Multi-camera 120V to 24VAC, 60Hz power supply with individual 1.85A max current, self-resetting overcurrent on each circuit. Provide quantity of units in each building as required by quantity of cameras to be powered. Provide 120V branch circuit and connection to each unit.

B. Multi-camera for outdoor cameras, 120V to 24VAC, 60Hz power supply with high power 4A individual circuits, isolated and fused outputs and built in system surge protection. Provide quantity of units in each building as required by quantity of cameras to be powered. Provide 120V branch circuit and connection to each unit.

C. Individual 120V to 24VAC, 60Hz, 80VA power supply with surge protection and screw terminals for 120V input. Provide unit in junction box above ceiling near camera. Provide 120V branch circuit and connection to unit.

D. Individual 120V to 24VAC, 60Hz, 80VA power supply with screw terminals for 120V input. Provide unit in weatherproof junction box mounted to structure near camera. Provide 120V branch circuit and connection to unit.

E. Where local 120V power is provided and transformed at individual cameras, provide line isolation transformers to prevent noise and interference due to ground loops, unbalanced voltages, etc.

F. Power supplies as manufactured by Altronix, Pelco or Preferred Power Products.

2.5 Cable Management System

A. Provide pre-manufactured cable supports. Cable supports shall be secured to building structure through threaded rod, beam clamps or other UL approved supports as required by site conditions. Components shall provide a minimum cable support point spacing of 48 inches.

B. Cable management devices must be sized to accommodate 100 percent spare capacity of the final installed cable base.

C. Cable management system shall be secured to building structure utilizing manufactured approved methods and hardware.

D. Cable management system support components shall be designed with wide support surfaces that do not cause cables to be bent, crushed or otherwise deformed when installed within component loading parameters. Cable management system shall meet UL standards and be UL labeled. Utilizing elements of the building's structure such as beams, joists, etc. to hang cable from will not be acceptable.

E. Bridle rings shall not be acceptable.

F. Manufactured by Panduit, Caddy, Mineralac or B-Line.

PART 3 - EXECUTION

3.1 General Installation

A. Install systems in accordance with UL, NEC and all other applicable codes. Install system to comply with drawings and final shop drawings in compliance with manufacturer instructions. Provide all required hardware and labor for rack mounting of head-end system components.

B. Refer to plans for locations and quantities of equipment. Equipment locations shown on plans will be required to be field coordinated to ensure proper system operation. The contractor shall provide adequate costs in the bid to locate interior cameras within 10 feet in any direction of the location indicated on the bid drawings. Exact location of each camera shall be coordinated with the owner in the field prior to installation. This coordination shall include a site survey with the owner in which the use of a field of view comparator is employed.

C. No items of equipment shall be installed in such a manner as to void or reduce the proper operating characteristics of individual components or of the system. Camera placement shall be coordinated with glass and exterior exposures to reduce or eliminate the requirement for sever back light compensation.

D. Perform all work under the on-site supervision of a factory authorized trained technician. It shall be the responsibility of the technician to check, inspect and adjust this installation to the engineer's and owner approval. A CSR of the installing contractor or manufacturer shall train the owner's personnel on the proper operation and maintenance of the equipment. Perform all work in conjunction with this installation in accordance with good engineering practices as established by NEC.

E. Camera Mounts: The Contractor shall install the camera mounts as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing, provide electrical and signal transmission cabling to the mount location as specified.

F. Cameras: The Contractor shall install the cameras with power and signal lines to the camera; aim camera to give field of view as required by owner.

G. Delivery of all loose equipment which is to be turned over to owner shall be carefully coordinated and scheduled with owner prior to shipment

3.2 Wiring Installation

A. CCTV wiring shall be furnished and installed in accordance with manufacturer's recommendations in compliance with all Local, State and National codes. This contract shall be responsible for furnishing and installing all required cabling between components to form a complete and operational system meeting all the requirements of this specifications.

B. Provide firestop material and seal all cable penetrations in the building.

C. All wiring between devices shall be run open wired above accessible ceilings. Where existing cable management systems are in place and there is adequate capacity to install the CCTV wiring, the contractor may utilize these pathways providing they have coordinated with all other wiring contractor on site. Where multiple runs are required all cables shall be bundled with approved cable ties on four foot centers.

D. Where pathways do not exist for SMS wiring, this contract shall be responsible for providing all required cable management systems such as J-hooks to support communications cabling to meet building codes and manufacturer's recommendations.

E. Cables shall not be laid upon ceilings or supported in a manner that would violate any codes or standards.

F. All cabling installed in ceiling spaces that are used for air distribution plenums shall be UL plenum rated.

G. All control and signal cable shall be installed continuous and without splices. Provide appropriate connectors or pre-manufactured cables for each application.

3.3 Telecommunications Rooms

A. The lay-out of the telecommunications rooms as depicted on the drawings shall be utilized as a general guide for bidding purposes. The final room layout shall be carefully coordinated with input from the owner and from other trades with equipment and/or cabinets to be placed in the room. Final configuration of telecom rooms shall be submitted to Engineer as a coordination drawing with information from all other trades occupying the same room for review prior to permanent mounting of equipment or termination of cabling.

B. Coordinate lay-out of telecom rooms to avoid placing telecommunications equipment and cabinets under water piping (other than sprinkler heads) or HVAC units.

C. Coordinate lay-out of telecom rooms with electrical plans and locations of electrical outlets.

D. Lay-out of telecommunications equipment cabinets and racks shall provide a minimum of 36 inches isle in front and behind equipment racks and cabinets which is clear of obstructions or equipment protrusions.

E. Coordinate rack locations and orientation to maintain required clearances including any equipment depths that may have to be accounted for. Some equipment, such as UPS units may have special mounting requirements that need additional coordination.

3.4 Grounding

A. The installing contractor shall be responsible for ensuring the grounding integrity of all installed equipment to eliminate the potential for equipment or personnel hazards due to improperly or inadequately grounded systems.

B. All grounding and bonding shall be in conformance with the National Electric Code, article 250 and as recommended by EIA/TIA-607.

3.5 Programming

A. It is the Contractor's responsibility to program the system in this section according to the Owner's wishes. This involves camera labeling, camera operation sequences, camera and recorder schedules, etc. The Contractor shall meet with the Owner and/or Engineer and reach agreement on the programming. This programming agreement shall then be written out in detail and forwarded to the Engineer for approval. After approval is granted, proceed with final programming.

B. Each building shall have the following minimum programming:

1. Camera labels programmed in each NVS/NVR.
2. Camera record rates based upon TOD schedules, alarm events, motion events.
3. Camera motion detection recording based upon TOD schedules. Motion detection scene masking.
4. PTZ cameras – Home position, tours, alarm pre-sets.
5. Camera username/password changed from the default to owner selected.

C. Additional programming at each building shall include set-up of graphical floor plans with interactive camera icons for all cameras local to that building.

3.6 Identification/Labeling

A. Contractor shall identify all major items of equipment and tag all cables with permanent type markers to denote equipment served. Cables shall be tagged at both ends and at each point where the cable is administered.

B. The contractor shall be responsible for generating and programming the labeling for camera information within the recorder software.

C. All labeling and recording shall be approved by the Owner and the Engineer prior to application.

3.7 Site Testing

A. General: The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Owner will witness all performance verification.

B. Contractor's Field Testing: The contractor shall place the entire system into operation and shall field verify that all aspects of the CCTV system including camera video, recording schedules, alarm events, GUI operation, System administration, etc. At the completion of testing, the contractor shall produce a written document indicating successful system testing.

C. Performance Verification Test: The Contractor shall demonstrate to the owner that all aspects, features and functions of the completed CCTV system comply with the contract requirements. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Owner, based on the Contractor's Field Testing sign-off. The Owner may terminate testing at any time when the system fails to perform as specified.

3.8 Training Requirements

A. Provide the owner with a minimum of 24 hours of training designed to make all users familiar with the operation of the system.

1. The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional manuals delivered for archiving at the project site. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. A training day is Monday through Friday, during normal working hours for the trained staff at the facility. Approval of the planned training schedule shall be obtained from the Owner at least 14 days prior to the training.
2. The course shall be taught at the project site only after successful completion of the Contractor's Performance Verification Testing. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of classroom instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The course shall include:
    a. General CCTV hardware, installed system architecture and configuration.
    b. Functional operation of the installed system and software.
    c. Operator commands.
    d. Fault diagnostics and correction.
    e. General system maintenance.
    f. Replacement of failed components and integration of replacement components into the operating CCTV system.
3. Provide all training and utilize specified manuals and record documentation. All training shall be provided at the project site and coordinated with the Owner.

B. Training shall utilize the equipment provided at the project site. Coordinate use, time and availability of equipment with the Owner.

C. Demonstrate adjustment, operation and maintenance of the system including each component and control.

D. This training period shall be scheduled with the Owner after the successful completion of the system.

3.9 As Built Documentation

A. Copies of all approved shop drawings with the Engineer's stamp.

B. Owner's manuals for every item of equipment when available from the manufacturer. These shall be the technical manuals provided by the manufacturer and shall not consist of generic sales brochures. Technical manuals shall provide complete specifications for the equipment as well as complete operating, maintenance, troubleshooting and product repair/replacement information. Where available only in electronic format, the contractor may provide a CD with electronic versions of Owner's manuals. CDs containing electronic versions of owner's manuals must contain the proper software viewers for each document type.

1. Interior Camera assembly including housing and lens
2. Exterior Camera Assembly including housing and lens.
3. Each type of camera power supply
4. Camera recorder
5. Racks/Cabinets
6. System Software.

C. Technology floor plan/site drawings updated with final as-Built information. This shall be in the form of a complete set of Technology drawings with as-built information indicated in colored pen based upon actual field conditions.

D. System schematic and block diagrams for every system updated with final as-built information. These drawings shall define the exact arrangement of each system including wiring configuration, device locations and cable types.

E. Rack elevations for all systems with rack mounted equipment.

F. Provide statement of warranty.

3.10 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from the date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide statement of this warranty with the O&M manuals.

B. During the first year's warranted operation, the Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

1. Visual checks and operational test of the multiplexer, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.
2. Correct all diagnosed problems.
3. Resolve any previous outstanding problems.

C. Make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

D. The Contractor shall be responsible to provide service during normal working hours within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system component

operation, or the loss of the video switcher or other head-end equipment. Provide an on-site authorized factory technician within 24 hours if required.

3.11 Certification

A. Upon completion of the testing, the manufacturer or representative shall issue to the Owner a letter of certification attesting to the fact that he has tested and adjusted the system, that all components are properly installed and free of defects, and that the system is in compliance with this specification

END OF SECTION

28 31 00 FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 System shall be a microprocessor based double supervised, closed circuit fire alarm system of modular design utilizing addressable technology for remote devices. Wiring shall be Class "B" for signaling and notification circuits. All units of equipment shall be labeled by Underwriters' Laboratories for fire alarm signaling use and shall comply with UL 864 Ninth Edition.

1.2 Operation of any addressable manual or automatic fire alarm initiating device shall initiate the following:

A. Sound a Code-3 temporal pattern audible fire alarm signal and illuminate fire signal lights in a synchronous mode until alarms have been silenced at the main fire alarm system control panel by means of the "alarm silence" switch or the device returned to normal and a "reset" switch is manually actuated.

B. Display alarm condition on integral alphanumeric LCD displays in the control panel(s), and remote annunciator(s), indicating the alarming device and its location. Each manual and automatic alarm initiating device shall be individually addressed.

C. Print the assigned English language message and activate control-by-event functions, with time and date, for the monitored point in alarm at the printer at the control panel.

D. Initiate a separate trouble and alarm signal for connection to the municipal fire department or remote monitoring service organization via leased telephone lines or as directed by the Owner.

E. Transmit a signal over two cellular communication transmission method meeting NFPA 72 requirements to a central station for fire alarm trouble and alarm conditions via the fire alarm digital communicator.

1.3 In the event of operating power failure or an open or a grounded circuit in the system, a trouble signal and trouble LED shall be activated until the system is restored to normal. The trouble event shall be recorded within the control panel historical trouble log, and printed on the system printer (when applicable). The trouble signal may be silenced by means of a button located on the control panel operator’s interface. Upon restoration of the system to normal condition, the trouble indicators shall automatically extinguish.

PART 2 - PRODUCTS

2.1 Equipment shall be equal in quality and performance to equipment as manufactured by Simplex Grinnell / Notifier (NESCO Affiliate), whose catalog numbers are used herein for establishing equipment criteria. Other acceptable manufacturers are Notifier (NESCO Affiliate) / Simplex Grinnell, EST/Edwards and Siemens Industry Inc.. Equipment supplier shall have a service organization within 50 miles of the project site and be a U.L. certified company. All material and/or equipment necessary for proper operation of the system not specified or described herein shall be deemed part of these specifications.

A. Remote system components as manufactured by Wheelock, Gentex or System Sensor are acceptable if UL listed and warranted as part of the total fire alarm system, provided by the fire alarm equipment supplier.

2.2 Fire Alarm Control Panel (FACP)

A. Control panel shall contain all necessary components to provide complete control, testing and indicating facilities for the entire fire alarm system. Relays, where employed, shall be pluggable type sealed in dustproof containers to prevent failure from dust, dirt, tampering and accidents. Unit shall facilitate silencing of alarm from one addressable device and shall resound on subsequent alarm from another addressable device. Unit shall be double supervised, individually annunciated by addressable point with, test switch, silencing switches, reset switches, control switches, power "on" lamp, 80 character LCD display, "Alarm" lamp, and a means of simultaneously testing all indicator lamps. Trouble signal shall be either an integrally mounted "Sonalert" signal or separately mounted 4 inch trouble bell with a SPL of 80 db at four feet, trouble alarm silence switch shall have ring back feature.

B. An alarm shall be displayed on an 80-character LCD display. This display shall indicate alarms, supervisory service conditions and any troubles. The top line of 40 characters shall be the point label and the second line shall be the device type identifier. The system alarm red LED shall flash on the control panel and the remote operator control panels until the alarm has been acknowledged at the control panel or the remote Operator Control Panels. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another point after acknowledged, shall flash the system alarm LED on the control panels. The LCD display shall show the new alarm information. A pulsing alarm tone shall occur within the control panel and the remote Operator Control Panels until the alarm is acknowledged.

C. The control panel shall be sized to accommodate 250 addressable devices, expandable to 500 addresses through the addition of Idnet card(s) within this control panel. Power supplies shall be supplied with 100 percent capacity including provisions for 10 percent additional strobe lights and 20 percent additional audible devices. Provisions for spare capacity shall include additional data loop cards or signaling cards to support the specified capacity. Audible signals shall be master controlled from the fire alarm panel to permit continuous signaling or master coded signaling in a Code-3 temporal pattern, panel selectable without making any modifications to remote devices. All visual alarm signals (strobe lights) shall be synchronized at the fire alarm panel. Audible signals shall be capable of being canceled independently of the visual alarm signals. Notifier 3030 / Simplex #4100U series with accessories.

D. Cabinet shall be modular construction, shall be surface mounted and shall accommodate all the modules, relays, terminal connections, and batteries necessary for system operation. Provide an outer door and frame assembly equipped with a lock and transparent door panel; manufacturer's standard enameled finish.

E. The control panel shall communicate individually with addressable initiating and control devices. Each device shall be individually annunciated at control panel.

1. Annunciation shall include the following:
    a. Alarm
    b. Trouble
    c. Open
    d. Short
    e. Device missing/failed
2. All addressable devices shall be capable of being disabled or enabled individually.
3. Smoke detectors shall utilize "Alarm Verification" operation.
4. Smoke sensor sensitivity shall be field-adjustable from the control panel for the analog style detectors. Control panel shall have self-test function such that each sensor is automatically tested once every 24 hours. Sensor shall notify control panel when maintenance is required. System shall automatically compensate for variations in environmental conditions.

F. Control Panel shall have a "Walk Test" feature.

G. Power Source

1. Operating power shall be supplied from a 120volt, 60 Hz circuit while the supervisory power shall be supplied from an integral DC power supply. The low voltage DC power supply shall consist of power limited, filtered and regulated power supplies with maintenance-free, lead-calcium battery back-up with automatic recharger; indication for normal supply and power supply trouble.
2. Batteries shall be sized to maintain system operation, including trouble alarm, for 24 hours with sufficient reserve capacity to power all alarm sounding devices for 5 minutes. Battery capacities shall be sized to include provisions for the spare strobe light and audible devices listed in the Part 3 - Execution section of this spec. All batteries shall be supervised.
3. Provide remote cabinet for batteries where size dictates need.
4. Door holders are required to be maintained by the standby batteries.

H. Provide surge suppressors ahead of all 120 volt power connections to the fire alarm equipment. Locate suppressors within equipment enclosure or in a junction box directly above the unit. Suppressors shall be Leviton #51020-WM or equal. These suppressors are in addition to internal protection provided with the fire alarm system's internal electronics.

2.3 Remote System Components

A. Miniplex transponders will communicate with the Main Fire Alarm Control Unit to provide for centralized control of alarm and trouble signaling as well as output signaling. The transponder shall be capable of limited stand-alone operation in the event the communication link to the central system is lost. Each transponder shall be furnished with all necessary controls, power supplies and battery back-up.

B. Manual stations shall be addressable communicating devices, shall have a red finish and shall be non-coded, single action with breakrod operation (glass rod not required to reset station), surface mounted with keyed reset switch. Simplex #4099-9001 / Notifier #NBG-12LX.

C. Protective shields for all manual stations shall be tamperproof, clear Lexan covers with red frames that are designed to mount over manual pull stations. When the Lexan cover is lifted to gain access to the manual station, a battery powered horn that is mounted integrally in the protective shield's red frame sounds a loud, local, audible signal until the cover is returned to its normal, closed position. Simplex #2099-9815 thru 18 or 21 as required / Notifier #STI-1100 w/horn. Exterior units shall be gasketed for all weather applications.

D. Fire signal lights (strobe lights) for synchronized operation shall provide visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and as shown on drawings in all other areas. Surface mount signal lights on walls where shown on the drawings. Lens shall be installed in a horizontal alignment on a red back plate labeled "FIRE" and shall produce 1 flash per second. Strobes shall be Simplex non-addressable #4904 Truealert Series / Notifier – System Sensor SpectrAlert Series with appropriate mounting hardware. Exterior units shall be gasketed and labeled for exterior use. Wheelock #WM3T / Notifier – System Sensor SpectrAlert Series (UL 1638 compliant).

E. Horns shall be surface mounted, with red grille and field selectable output levels of 85 or 91 dB at 10 ft. (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 85 dB and adjusted upward as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for these units operating at 91 dBA. Outside assemblies shall be weatherproof. Combination

(audible/visible) horn and fire signal lights shall utilize a compact, combination mounting base assemblies. Horns shall be labeled "Fire". Wheelock #MT Series / Notifier – System Sensor SpectrAlert Series (utilize the continuous horn signal setting) with mounting accessories. Exterior units shall be gasketed for weatherproof rating. Combination strobe/horn signal units shall be factory assembled Wheelock #MT+ Series / Notifier – System Sensor SpectrAlert Series.

F. Combo horns with fire signal lights (strobe lights) for synchronized operation shall provide both audible and visual indication of all alarms and shall illuminate in a synchronized flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and as indicated in all other areas as shown on drawings. Surface mount signals on walls where shown on the drawings. Lens shall be installed in a horizontal alignment and shall produce 1 flash per second. Horns shall be supplied with a red grille / cover and labeled "FIRE" and shall have field selectable output levels of 90 or 95 dBA at 10 feet (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 90 dB and adjusted up or down as required for proper sound coverage during the final checkout. Power calculations shall be made using the current draw for these units operating at 95 dB. All strobes shall be synchronized throughout the entire building utilizing control circuitry within the main fire alarm panel (and extender panels if used). Exterior units shall be gasketed and labeled for exterior use. Simplex non-addressable #4903 True Alert series / Notifier – System Sensor SpectrAlert Series.

G. Surface mounted fire alarm devices mounted on walls - such as manual stations, horns, fire signal lights, etc. shall utilize finished backboxes. These backboxes shall be red metal and shall be field punched for conduit entrance and shall not employ stamped K-O construction.

H. Photo-electric type, addressable, ceiling mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at .5 percent to 3.7 percent light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individual adjustable through the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. Detector head shall have a white finish, shall contain an integrally mounted LED pilot lamp that indicates detector status. Simplex #4098-9714 with #9792 base / Notifier #FSP-851 W/B710LP Base. Provide remote LED alarm indicators where indicated.

I. Photo-electric type, addressable duct mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at .5 percent to 3.7 percent light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individually adjustable through the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. The detector shall contain an integrally mounted LED pilot lamp that indicates detector status. Simplex #4098 Series housing with #4098-9714 detector / Notifier #FSD-751P. A remote mounted test/reset switch with "status" pilot lamp shall be flush mounted at 54 inch mounting height in a convenient location within sight of air handling unit, Simplex #2098-9806 / Notifier #RTS-451. Provide auxiliary contact/relay in base of units to control smoke dampers, Simplex #4098-9843 PAM Relay / Notifier #FRM-1-PAM Relay.

J. Waterflow switches shall indicate the continuous flow of water in sprinkler pipes. Switches shall be furnished and installed by the Fire Suppression Contractor. Wiring and connection shall be by this Electrical Contractor. Unit shall be equipped with retard mechanism, adjustable up to two minutes, to minimize false alarms due to pressure changes. Coordinate pipe size with Fire Suppression Contractor. Units are to be turned over to Fire Suppression Contractor for installation. Each waterflow switch shall be connected to the fire alarm system

through a dedicated address via a monitor module. Simplex #2097-9047 thru 9054 depending on pipe size / Notifier #WFD.

K. Gate valve switches (OS&Y) shall monitor the status of sprinkler valves where indicated on drawings and shall signal a trouble alarm when respective valve is closed. Switches shall be furnished and installed by the Fire Suppression Contractor. Wiring and connection shall be by this Electrical Contractor. Each gate valve switch shall be connected to the fire alarm system through a dedicated address via a monitor module. Simplex #2097-9032 / Notifier #OSY+2. Units are to be turned over to the Fire Suppression Contractor for installation.

L. Post indicator valve switches shall monitor the status of sprinkler valves where indicated on the drawings and shall signal a trouble alarm when valve is closed. Switches shall be furnished and installed by the Fire Suppression Contractor. Wiring and connection shall be by this Electrical Contractor. Simplex #2098-9046 (PCVS) / Notifier #PIBV2. Units are to be turned over to the Fire Suppression Contractor for installation. Each PIV switch shall be connected to the fire alarm system through a dedicated address via a monitor module. Provide a Simplex #2081-9044 / Notifier surge suppressor where monitor wiring leaves the building.

M. Remote Annunciator and Operator Control panels shall be surface wall mounted where shown on plans. Each shall consist of an 80-character LCD display with primary control features similar to the main controller located in the fire alarm control panel. Control buttons are behind a locked window to prevent unauthorized operation. Simplex #4603-9101 / Notifier #FDU-80.

N. Notification appliance power extender control panels shall be provided where shown on the drawings. These panels shall communicate with and be completely supervised from the main fire alarm panel and shall be capable of powering additional synchronized visual alarm signals and/or audible alarm signal circuits. Each panel shall include supervisory modules, power supplies, batteries and chargers. At the Contractor's option, additional extender panels may be utilized. Coordinate exact locations of these additional remote panels with the Architect/Engineer during the submittal phase. Operating power (120V) shall be supplied from the emergency system where available on the premise. Simplex #4009-9201 / Notifier #FCPS-24 Series panel with accessories.

O. Provide a recessed Knox-Box rapid entry system where indicated on drawings. Extend wiring from the Knox-Box tamper switch to the building alarm system.

2.4 The fire alarm supplier shall submit for approval with shop drawings, floor plans, schematic and point to point wiring diagrams showing all manual and automatic devices, control panels, sounding devices, conduit sizes, number and size of wires, etc. Shop drawings shall include calculations for sizing of signal power supplies, voltage drop calculations for audible and visual signal circuits (including provisions for future devices), speaker amplifiers and standby batteries. Voltage drop calculations will be based on each strobe drawing 110 percent of operating current and each audible device drawing 120 percent of operating current to allow for future devices. Submittal shall include copies of personnel certification as required in 3.1. SHOP DRAWINGS WILL BE REJECTED UNLESS THE SUBMITTAL INCLUDES ALL THIS REQUIRED INFORMATION.

2.5 At completion of the project, the wiring diagrams shall be revised "as built" and included as part of the maintenance manuals. The fire alarm supplier shall also furnish a hard copy printout of each detector's address, operating routines, etc. as part of the as-built drawings. Additionally, the supplier shall include an electronic copy (in a digital media format acceptable to the Owner) of the system's operating program with the as-builts for the Owner's records.

2.6 The Contractor or his fire alarm supplier/installer shall submit shop drawings, after the Architect's and Engineer's review, to the State Fire Marshal's Office where applicable for their review and

approval. Where buildings are not under the jurisdiction of the State Fire Marshal, the shop drawings shall be submitted to the local fire official for review and approval. The fire alarm supplier / installer shall provide sealed documents for submittal to the inspection authority.

PART 3 - EXECUTION

3.1 Follow NFPA 72 and manufacturer's instructions regarding mounting, wiring and testing system. Installer(s) shall meet project's respective State and local Municipality requirements for certification and as a minimum, have one installer certified as a NICET Level 2. In addition, the fire alarm system supplier shall have on staff, one NICET Level 3 certified individual and be an U.L. certified company.

3.2 Wiring, #14 AWG minimum, shall be installed in accordance with manufacturer's wiring diagrams, recommendations and in compliance with practices set forth by local, state and national fire codes. Color code and tag all wires at all junction points. #18 AWG conductors may be utilized when installed as a multi-conductor cable with an overall protective jacket when approved by manufacturer. All fire alarm system wiring shall comply with NEC Article 760.

3.3 Duct mounted smoke detectors shall be located per U.L. and manufacturer's guidelines to permit easy access for maintenance and testing. Provide access panels where required. Assure accessibility to the entire assembly.

3.4 All wiring shall be installed in conduit; conduit system shall be independent of all other systems.

3.5 Provide protection, such as wire guards, which are listed for the specific use on all fire alarm devices within gyms, locker rooms, multi-purpose rooms and other areas subject to mechanical damage.

3.6 Provide a smoke detector at the location of each fire alarm control unit (main panel, auxiliary control panels and remote annunciators) and extend into the system.

3.7 The following wiring and conduit shall be included in the fire alarm system work in addition to that indicated above:

A. Empty conduit with pullwire from the digital communicator to the main telephone backboard. Telephone wiring from the telephone backboard to the digital communicator is the Contractor's responsibility. Assist in making final connections at the digital communicator and verify transmission to and receipt by the Central Station.

B. From fire alarm panel, duct mounted smoke detector, or control relay module to each air handling unit and exhaust fan for shutdown.

3.8 Upon completion and before acceptance, system performance shall be demonstrated in the presence of the Architect and Construction Manager that all specified functions are accomplished and that response is accomplished from all initiating and indicating devices. Provide step-by-step user instructions with graphics identifying operator controls for normal user operations such as silencing of alarms, resetting of system, locking and unlocking controlled doors, etc. Each normal operation shall be on a separate page and all pages shall be laminated for durability and assembled in a three ring "operators manual". This manual is in addition to shop drawings and maintenance manuals.

3.9 System shall be tested by and a certificate of inspection shall be furnished by a qualified manufacturer's representative or equipment vendor; submit report indicating results to the Architect and Construction Manager. This testing shall be done with the building HVAC systems in operation and the manufacturer's representative shall field check the dBA readings in accordance with levels established by NFPA. During this checkout period, adjust audible device output levels as needed.

3.10 Warranty

A. Warrant all workmanship, equipment, material and software entering into this contract for a period of three (3) years from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect and Construction Manager. Any materials or equipment proving to be defective during the warranty period shall be made good without expense to the Owner. Provide a statement of this warranty with the O & M manuals.

B. During the warranted operation, provide an annual inspection (for a total of 3). This work is inclusive with the warranty and shall be performed during regular working hours, Monday through Friday, excluding legal holidays, as coordinated with the Owner. Provide an inspection report to the Owner.

C. Provide service during normal working hours on a normal business day within (4) hours after notification by the Owner for normal service or within (2) hours for emergency service. Emergency service is defined as the loss of 25 percent or more of system components operation or the loss of the head-end equipment which renders the system un-usable. Provide an on-site authorized factory technician within 24 hours if required.

D. If equipment components cannot be repaired within 24 hours of service visit, provide “loaner” equipment components to the Owner at no charge.

3.11 Base bid includes five (5) additional combination audible/visual alarm signals 30 / 75 cd, two (2) additional ceiling mounted smoke detectors and two (2) additional duct mounted smoke detectors, complete with installation, power supplies and fifty (50) feet of conduit with circuitry per device. These additional base bid devices shall also include any related submissions to the AHJ, revised “as-builts”, related system programming and revised Owner electronic copy. The audible/visual signals and smoke detection shall be added where designated by the Engineer at the time of final acceptance.

END OF SECTION

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and **removing site utilities**.
7. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

C. Utility Locator Service: Notify **Ohio Utility Protection Services (OUPS)** for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than **two** days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

3.4 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for **slabs-on-grade**, **walks, pavements**, **turf and grasses**, **and plants**.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete **walks and pavements**.
6. Subbase course **and base course** for asphalt paving.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each **on-site and borrow** soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to **ASTM D 698**.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify **Ohio Utility Protection Services (OUPS)** for area where Project is located before beginning earth-moving operations.

C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in **Section 311000 "Site Clearing"** are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification **Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487**, or a combination of these groups; free of rock or gravel larger than 1.5 **inches** in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification **Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487**, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

2.2 GEOTEXTILES

A. Refer to pavement details

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

3.7 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade **below the building slabs and pavements** with a pneumatic-tired **and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons** to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction**, repeating proof-rolling in direction perpendicular to first direction**. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for **changes in the Work**.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing.

D. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of **specified material**, free of particles larger than **3/4 inch** in any dimension, to a height of 12 inches over the pipe or conduit.

a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than **8 inches** in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to **ASTM D 1557**:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at **95** percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at **85** percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at **85** percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus **1 inch**.
2. Walks: Plus or minus **1/2 inch**.
3. Pavements: Plus or minus **1/2 inch**.

C. Grading inside Building Lines: Finish subgrade to a tolerance of **1/2 inch** when tested with a 10-foot straightedge.

3.16 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course **and base course** on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course **and base course** under pavements and walks as follows:
1. Shape subbase course **and base course** to required crown elevations and cross-slope grades.
2. Compact subbase course **and base course** at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 90 percent of maximum dry unit weight according to **ASTM D 1557**.

3.17 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Place drainage course 6 inches or less in compacted thickness in a single layer.
2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 316316 - AUGER CAST GROUT PILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes auger cast grout piles.

1.3 UNIT PRICES

A. Contract Sum: Base Contract Sum on number and dimensions of piles from tip to pile top.

B. Work of this Section is affected as follows:

1. Pile Length: Additional payment for pile lengths in excess of that indicated, and credit for pile lengths less than that indicated, is calculated at unit prices stated in the Contract, based on net addition or deduction to total pile length as determined by Architect and measured to nearest 12 inches.
2. Number of Piles: Additional payment for number of piles in excess of that indicated, and credit for number of piles less than that indicated, is calculated at unit prices stated in the Contract.
3. Unit prices include labor, materials, tools, equipment, and incidentals for excavation, grout fill, reinforcement, testing and inspection, and other items for complete pile installation.
4. Test piles that become part of permanent foundation system are considered as an integral part of the Work.
5. No payment is made for rejected piles, including piles out of specified tolerance or defective piles.

C. Test Piles: Same unit price as indicated for production piles.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each grout mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Shop Drawings: For auger cast grout piles.

1. Identify each pile and indicate pile dimensions, cross sections, locations, and sizes.
2. Indicate types and configurations of reinforcement and detail fabricating.

3. Detail connections to pile caps.
4. Include method of centralizing reinforcement, type and size of centralizing devices, and locations on reinforcing bars.
5. Static Pile Tests: Include arrangement of static test pile reaction frame, test and anchor piles, equipment, and instrumentation. Submit structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For the following:

1. Cementitious materials.
2. Concrete admixtures.
3. Steel reinforcing.

C. Equipment Data: Description of drilling and grout-pumping equipment including the following:

1. Type and make of drilling rig, rated capacity, and boom lengths.
2. Torque of drilling machine and horsepower of hydraulic power unit.
3. Pressure and discharge capacity of grout pump.
4. Automated monitoring equipment to be used.

D. Static Pile Test Reports: Submit within three days of completing each test.

E. Pile Inspection Reports: Submit not later than the morning of the next working day after placing each pile.

F. Certified Piles Survey: Submit within seven days of completion.

1.6 CLOSEOUT SUBMITTALS

A. Record Drawings.

B. Certified Pile Survey: Submit within seven days of pile installation completion.

1.7 QUALITY ASSURANCE

A. Mix Designs: For each type of grout. Include description of type and proportions of ingredients.

1.8 PRECONSTRUCTION TESTING

A. Test Piles: Construct of diameter, depth, and at locations indicated on Drawings or, if not indicated, of same diameter and depth as largest production piles and at locations selected by Architect, to confirm allowable load of piles and demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

1. If Architect determines that test pile does not comply with requirements, excavate for and cast another until it is accepted.
2. Tests: Arrange and perform the following pile tests:

a. Axial Compressive Static Load Test: ASTM D1143, Procedure A, Quick Test

3. Equip each test pile with two telltale rods, according to ASTM D1143, for measuring deformation during load test.
4. Provide pile reaction frame, anchor piles, equipment, and instrumentation with enough reaction capacity to perform tests. Notify Architect at least 48 hours in advance of performing tests. On completion of testing, remove testing structure, anchor piles, equipment, and instrumentation.

    a. Allow a minimum of seven days to elapse after installing test piles before starting pile testing.
    b. Number of Test Piles: One pile.

5. Approval Criteria: Allowable load shall be the load acting on the test pile when the lesser of the following criteria are met, divided by a factor of safety of 2:

    a. Net settlement of not more than 0.01 inch/ton of test load.
    b. Total settlement of 1 inch provided the load settlement curve shows no sign of failure.
    c. A plunging failure or sharp break in the load settlement curve.

6. Test Pile Records: Prepare records for each test pile. Include same data as required for permanent piles.
7. Test piles that comply with requirements, including location tolerances, may be used on Project.

1.9 FIELD CONDITIONS

A. Protect structures, underground utilities, and other construction from damage caused by pile excavation.

B. Site Information: A geotechnical report has been prepared for this Project and it is available upon request.

C. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for auger cast grout piles. Before excavating, lay out each pile to lines and levels required. Record actual measurements of each pile's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

    1. Record and maintain information pertinent to each pile and indicate on record Drawings. Cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60, deformed.

B. Single Bar Reinforcing: ASTM A722, high strength, threaded.

1. Mechanical Couplings: Screw-on type, capable of supporting the minimum ultimate tensile strength of the coupled bars.

C. Centralizers: Devices to center steel reinforcement in excavation; spaced not less than 20 feet o.c. for vertical piles.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, Type I.

B. Fine Aggregate: ASTM C33 with 100 percent passing a No. 8 sieve, free of materials with deleterious reactivity to alkali in cement. Provide aggregate from single source.

C. Water: ASTM C94 and potable.

D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
3. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
4. Plasticizing and Retarding Admixture: ASTM C1017, Type II.

E. Fluidifier: ASTM C937, with expansion of less than 4 percent.

2.4 RELATED MATERIALS

A. Pile-Top Forms: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes. Provide units with enough wall thickness to resist plastic concrete loads without detrimental deformation. Diameter same as pile diameter.

2.5 GROUT MIXTURES

A. Prepare design mixtures for each type and strength of grout, proportioned on the basis of laboratory trial mixture, field test data, or both.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Proportion grout mixture as follows:

1. Minimum Compressive Strength at 28 days: As noted in structural drawings; ASTM C109 with cube specimens restrained from expansion according to ASTM C942.
2. Maximum Water-Cementitious Materials Ratio: 0.43.
3. Grout Flow: 10 to 25 seconds; ASTM C939 and ASTM C109 using a flow cone with 0.75-inch opening.

2.6 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.7 GROUT MIXING

A. Ready-Mixed Grout: Measure, batch, mix, and deliver according to ASTM C94, and furnish batch ticket information.

1. Temperature Limits: Comply with ACI 305.1 for hot weather and ACI 306.1 for cold weather.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, and other hazards created by drilling operations.

B. Rough grade ground elevation at pile locations to a minimum of 12 inches above required cutoff elevation.

3.2 DRILLING AND PUMPING EQUIPMENT

A. Drilling Rig: Capable of advancing hollow-stem, continuous-flight augers of design diameters to depths 20 percent greater than design depths; with stabilizing arm at bottom of leads to prevent rotation, and middle guide for augers greater than 40 feet in length.

1. Mark leads at maximum 60-inch intervals to facilitate measurement of penetration.

B. Hollow-Stem Auger: Continuous auger flighting without gaps or breaks, of diameter no more than 3 percent less than pile diameter; with grout pumping hole at bottom of auger head below cutting teeth. Seal grout-pumping hole with temporary tip plug to be fully opened by grout pressure or reinforcing bar during grout installation.

1. Hollow Shaft Diameter: Minimum 1-1/4-inch clear ID.

C. Grout Pump: Positive-displacement pump with a known volume per stroke. Minimum displacement pressure at pump of 350 lbf/sq. in..

D. Automated Monitoring Equipment: Capable of measuring auger depth, penetration rate, and grout volume pumped per unit depth increment and of printing results.

3.3 EXCAVATION

A. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

B. Advance auger at a continuous rate during insertion that prevents removal of excess soil.

C. Excavate piles to auger refusal, defined as a rate of auger penetration of less than 1 foot per minute of drilling using a drill rig with a rated torque of not less than 30,000 foot pounds. Establish and maintain axial alignment of leads and shaft before and during driving.

D. Drilling Tolerances:

1. Location: Pile centers maximum 2 inches from locations indicated.
2. Plumb: Within 2 percent from vertical.
3. Batter Angle: Within 4 percent from required angle.

3.4 INSTALLATION

A. Maintain positive (clockwise) rotation of auger during withdrawal. Promptly remove excavated spoils to prevent accumulation.

B. Grout Placement: Place grout in continuous operation.

1. Lift auger 6 to 12 inches at start of grout pumping to facilitate tip plug removal, then return to previously established tip elevation.
2. Develop an initial grout head of 60 inches before start of auger withdrawal and maintain during extraction.
3. Monitor pumped grout volumes using automated monitoring equipment.
4. Volume of placed grout is at least 115 percent of theoretical volume. If less than required volume is placed for any given 60-inch segment, lower auger a minimum of 60 inches, or to bottom of pile if less than 60 inches available, and restart withdrawal.
5. If grout pumping is interrupted during placement, lower auger a minimum of 60 inches , or to bottom of pile if less than 60 inches available, and restart withdrawal.

C. Steel Reinforcement Installation, General: Comply with recommendations in CRSI's "Manual of Standard Practice."

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with grout.
2. Screen pile top to remove spoils immediately after auger withdrawal and before placing reinforcement.

D. Single Bar Reinforcing: Install through center of hollow-stem auger before grout placement.

E. Pile Completion:

1. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation with pile-top form.
2. Where cutoff elevation is below the ground elevation, cut off top of piles at elevations indicated by removing fresh grout from the top of pile or cutting off hardened pile top after initial set.

F. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Architect for review before proceeding.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Pile excavation, placement, and testing.
2. Steel reinforcement welding.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Grout Tests: Testing of samples of fresh grout obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Flow Rate: ASTM C939 and ASTM C109 using a flow cone with 0.75-inch opening.
2. Compressive Strength: ASTM C109 with cube specimens restrained from expansion according to ASTM C942.

    a. Testing Frequency: Obtain six 2-inch cubes for each 50 cu. yd. or fraction thereof of grout placed, but not less than one set for each day's pour. Obtain an additional set of cubes from each truck during test pile placement.
    b. Test two cubes at 7 days, two cubes at 28 days, and hold two cubes in reserve.
    c. Strength of each grout mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
    d. Report test results in writing to Architect, grout manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of placement, name of testing and inspecting agency, location of grout batch in Work, design compressive strength at 28 days, grout mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
    e. Additional Tests: Testing and inspecting agency to make additional tests of grout if test results indicate that compressive strengths or other requirements have not been met, as directed by Architect.
    f. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
    g. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Low-Strain Integrity Testing: Performed and reported according to ASTM D5882 on five single piles and reported for each pile.

E. Pile Inspection Reports: Prepare inspection reports for each auger cast grout pile as follows:

1. Pile location.
2. Pile diameter.
3. Actual top and bottom elevations.
4. Final top centerline location and deviations from requirements.
5. Variation from plumb.
6. Date and time of starting and completing.
7. Position and condition of reinforcing steel and splices or mechanical couplings.
8. Automatic monitoring equipment record including grout volume actually pumped.
9. Grout testing results.
10. Remarks, unusual conditions encountered, and deviations from requirements.

F. Certified Piles Survey: Prepared by a qualified land surveyor or professional engineer showing final location of piles in relation to the property survey and existing benchmarks.

1. Notify Architect when deviations from locations exceed allowable tolerances.

G. Auger cast grout piles will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 316613 – DEEP GROUND IMPROVEMENT WITH STONE COLUMNS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes designing, furnishing, and completing deep ground improvement work using compacted stone aggregate columns. The columns shall be either vibrated stone columns or rammed aggregate piers. “Rammed aggregate piers” referenced in these specifications refer to both vibrated stone columns and rammed aggregate piers.

B. Related Sections include the following (but not limited to):
   1. Division 3 Section "Cast-in-Place Concrete" for concrete footings.
   2. Division 31 Section “Earthwork”

1.3 DEFINITIONS

A. Stone Columns: Stone columns shall be constructed by compacting aggregate in an excavated hole using special high-energy impact or vibratory densification equipment. The aggregate pier elements shall be in a columnar-type configuration. The system of column elements shall be used, in conjunction with the densified soil, to produce an intermediate foundation system for supporting foundation loads consisting of shallow spread footings.

1.4 LUMP SUM

A. The Aggregate Pier Installer (the Installer) shall design and install the aggregate pier foundation system, including required load tests, as a lump sum price.

1.5 REFERENCE STANDARDS

A. Design: The aggregate pier installer shall be responsible for design of a vibrated stone column or rammed pier ground improvement system that meets the global stability, allowable bearing capacity, and settlement requirements stated in the Drawings. Industry-recognized standards and design methods specific to the installer’s equipment and construction methods shall be used.

B. Materials and Inspection
   1. ASTM C33/C33M - Standard Specification for Concrete Aggregates.

1.6 PERFORMANCE REQUIREMENTS

A. Geotechnical Performance: Provide aggregate pier foundation system capable of supporting the designed structure. The design submitted by the Installer shall consider

the bearing capacity and settlement of all footings supported by aggregate piers and shall be in accordance with acceptable engineering practice and the Contract Documents. Total and differential settlement shall be considered.

1. Aggregate piers shall be designed according to generally accepted engineering practice and meet the bearing and settlement criteria shown in the Drawings.

2. Pier/stone column lengths shall be determined by the pier design, not less than 10 feet.

1.7 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate number, depth, and location of piers.

C. Delegated Design Data: Submit the following:
   1. Detailed design calculations.
   2. Description of quality control and field testing program.
   3. Documentation of delegated design data sealed by a Professional Structural Engineer licensed in the State of Ohio.
   4. Description of installation methods.

D. A plate load test shall be carried out on a 10 foot by 10 foot steel plate. The plate shall be loaded in increments in a manner similar to a quick pile load test to a top load of 1,000 kips (i.e. 10 ksf). Ground improvement contractor to furnish a signed and sealed report of the complete plate load test.

E. Field Quality Control Submittals: Submit daily.
   1. Pier and footing location.
   2. Volume of aggregate.
   3. Installed pier depth.
   4. Number of lifts.
   5. Description of placement method and forces applied.
   6. Design elevation at top and bottom of pier.
   7. Actual, installed elevation at top and bottom of pier.
   8. Documentation of unusual or unexpected conditions encountered.
   9. Description of aggregate used.

F. Designer's Qualification Statement.

G. Installer's Qualification Statement.

H. Welder's Qualification Statement.

I. Testing Agency Qualification Statement.

J. Project Record Documents: Record actual locations of piers, pier diameter, and pier length. Accurately record the following on project record documents:
   1. Sizes, lengths, and locations of piers and footing groups.
   2. Sequence of placement.
   3. Final base and top elevations.

4. Deviation from indicated locations.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer shall have demonstrated experience in the construction of similar size and types of projects. Installer shall have successfully completed a minimum of 5 stone column supported structures within the past five years in the State of Ohio. The Installer's superintendent shall have successfully completed a minimum of 5 stone column projects.
   1. Designer: Installer shall engage a qualified professional engineer to perform detailed geotechnical design and settlement analysis of the deep ground improved foundation system.

B. Survey Work: The Installer shall engage a qualified land surveyor to perform surveys, layouts, and measurements for aggregate piers. Before excavating, lay out each aggregate pier to lines and levels required. Record actual measurements of each aggregate pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
   1. Record and maintain information pertinent to each aggregate pier and cooperate with the Installer’s testing and inspecting agency to provide data for required reports.

C. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the state of Ohio and who is experienced in providing engineering services of the kind indicated.

1.9

A. Land Surveyor Qualifications: A land surveyor who is legally qualified to practice in the State of Ohio and who is experienced in providing layout services of the kind indicated.

1.10

A. Source Limitations: Obtain aggregate from one source.

B. Plate Load Test: Prior to installation of aggregate piers, provide pier load tests as follows. The load tests shall be supervised by the Installer's Geotechnical Representative and the Owner’s Geotechnical Representative.
   1. Installer shall provide all necessary equipment to perform the pier load tests.

   2. Test piers shall not become part of the permanent foundation system.
   3. The plate load test should be completed on a minimum 10-ft by 10-ft reinforced steel plate that is loaded in increments to a maximum top load of 1,000 kips.

G Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.11 PROJECT CONDITIONS

A. Existing Utilities: The Installer shall locate existing underground utilities before installing piers. If utilities are to remain in place, provide protection from damage during pier installation operations.
   1. Should uncharted or incorrectly charted piping or other utilities be encountered during installation, adapt installation procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and

facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Site Information: A geotechnical report has been prepared for this Project and is included elsewhere in the Project Manual for information only.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aggregate

1. Aggregate used for piers constructed above the water table shall be ASTM C-33 No. 57 stone, or shall be other graded aggregate selected by the Installer and successfully used in the load test.

1.12

2. Aggregate used for piers constructed below the water table shall be ASTM C-33 No. 57 stone, except that particles passing the No. 40 sieve shall be eliminated, or other aggregate selected by the Installer and successfully used in the load test.

1.13

B. Water: Potable

PART 3 - EXECUTION

3.1 PREPARATION

A. Use placement method that will not cause damage to nearby structures.

B. Notify adjacent and affected land owners and building occupants with 90 days notice before proceeding with the Work.

C. Protect structures near the Work from damage.

D. Prepare to place piers from excavated working elevation. Do not begin installation until ground elevation at each pier location is at least 12 inches higher than indicated top bearing level of pier/stone column.

3.2 INSTALLATION

A. Piers shall be installed consistent with the design submittals and approved methods.

B. Set top bearing levels of piers to elevations indicated.

C. Prepare pier top to receive spread footing.

3.3 TOLERANCES

A. Maximum Variation From Vertical: 1 in 48.

B. Maximum Variation From Design Top Elevation: 4 inches.

C. Maximum Out-of-Position: 6 inches.

3.4 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01 4000 - Quality Requirements.

B. Perform plate load tests as indicated in Part 1.

C. Accepted test piers may not be used in the Work.

3.5 UNACCEPTABLE PIERS

A. Unacceptable Piers: Piers that fail, are placed out of position, are below elevations, or are damaged.

B. Abandon unacceptable piers in place. Provide additional piers as required by the specialty engineer, to be approved by the Architect.

C. Remove unacceptable piers and replace with new piers that comply with specified requirements, as directed by Architect.

D. All material and labor required to replace rejected piers shall be provided at no additional cost to the owner, unless the cause of rejection is due to an obstruction or mislocation.

END OF SECTION 316613

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include technical data and tested physical and performance properties.
   2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
   3. Job-Mix Designs: For each job mix proposed for the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material. **Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.**

B. Material Test Reports: For each paving material, by a qualified testing agency.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: **A paving-mix manufacturer registered with and approved by ODOT.**

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of ODOT specification for asphalt paving work.

   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of 60 deg F.
   2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations according to ODOT specifications.

2.2 ASPHALT MATERIALS

A. General: Use materials and gradations according to ODOT specifications.

B. Tack Coat: General: Use materials and gradations according to ODOT specifications.

C. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

   1. Completely proof-roll subgrade in one direction[**, repeating proof-rolling in direction perpendicular to first direction**]. Limit vehicle speed to 3 mph.
   2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

3.3 SURFACE PREPARATION

A. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 PLACING HOT-MIX ASPHALT

A. General: Follow method according to ODOT specifications.

B. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at a minimum temperature of 250 deg F (121 deg C).
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

C. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.

4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to **ASTM D 6927**, but not less than 94 percent or greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041/D 2041M, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or ¼ inch, no minus.

2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

3.8 FIELD QUALITY CONTROL

A. Testing Agency: **Owner will engage** a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549/D 3549M.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to **ASTM D 979/D 979M**.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041/D 2041M, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726/D 2726M.
    a. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726/D 2726M.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes Concrete Paving **Including the Following:**

1. Driveways.
2. Curbs and gutters.
3. Walks.

B. Related Requirements:

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Fiber reinforcement.
3. Admixtures.
4. Curing compounds.
5. Joint fillers.

1.6 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from steel wire into flat sheets.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150/C 150M, **gray** portland cement **Type IA**.
2. Fly Ash: ASTM C 618, **Class C**.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, **Class 4M**, uniformly graded. Provide aggregates from a single source **with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials**].

1. Maximum Coarse-Aggregate Size: **3/4 inch** nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

E. Water: Potable and complying with ASTM C 94/C 94M.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 , for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

B. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

C. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

D. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate.

E. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): **4000 psi**.
2. Slump Limit: **4 inches**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of **50 feet** unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, **to match jointing of existing adjacent concrete paving**:

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a **3/8-inch** radius. Repeat tooling of edges after applying surface finishes.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

F. Consolidate concrete according to by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating joint devices.

G. Screed paving surface with a straightedge and strike off.

H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

I. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

J. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: **Owner will engage** a qualified testing agency to perform tests and inspections.

3.9 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes painted markings applied to **concrete** pavement.

B. Section refers to directional “Arrows” within the garage.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of ODOT Item 740.02 “Traffic Paint” for pavement-marking work.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of **55 deg F for water-based materials**, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: Type 1, fast dry, water-based, 100 precent acrylic type marking paint.

1. Color: **White**.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates..

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

SECTION 323223 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes single-depth segmental retaining walls without soil reinforcement.

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavation for segmental retaining walls.

1.3 ACTION SUBMITTALS

A. Product Data: For Allan Blocks.

B. Samples: For each color and texture of concrete unit specified. Submit full-size units.

C. Delegated-Design Submittal: For segmental retaining walls.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Research/Evaluation Reports: For segmental retaining wall units, from ICC-ES.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.

B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of another manufacturer are proposed, engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design segmental retaining walls.

B. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.

C. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls".

1. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.

2.2 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

1. Allan Block
2. Provide units that comply with requirements in ASTM C 1372 for freeze-thaw durability.

B. Color: Stonecreek and Hickory Blend

C. Shape and Texture: Provide units matching basic shape, dimensions, and face texture of basis-of-design product.

D. Batter: Provide units that offset from course below to provide at least 1:8 batter.

E. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.

F. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

2.3 INSTALLATION MATERIALS

A. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

B. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for drainage course.

C. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.

D. Reinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

E. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.

F. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

G. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
2. Minimum Grab Tensile Strength: 110 lb; ASTM D 4632.
3. Minimum Weight: 4 oz./sq. yd.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect each roll of soil reinforcement for minimum average roll values for geosynthetic index property tests, including the following:

1. Weight.
2. Grab or single-rib strength.
3. Aperture opening.
4. Rib or yarn size.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.

1. Lay units in running bond.
2. Form corners and ends by using special units.

B. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet where such defects are exposed in the completed Work.

C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.

D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.

1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

1. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.

F. Cap Units: Place cap units and secure with cap adhesive.

3.3 FILL PLACEMENT

A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide," and with segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.

1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.
2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.

    a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.

3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."

D. Place drainage geotextile against back of wall, and place layer of drainage fill at least 12 inches wide behind drainage geotextile to within 12 inches of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

E. Place impervious fill over top edge of drainage fill layer.

F. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.

3.4 CONSTRUCTION TOLERANCES

A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.

B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.

C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.

D. Maximum Gap between Units: 1/8 inch.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.

1. In each compacted backfill layer, perform at least one field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length.

3.6 ADJUSTING

A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
2. Segmental retaining walls that do not match approved Samples.
3. Segmental retaining walls that do not comply with other requirements indicated.

B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 323223

SECTION 334200 - STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. PE pipe and fittings.
2. PVC pipe and fittings.
3. Manholes.
4. Concrete.
5. Catch basins.
6. Stormwater inlets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Manholes: Include plans, elevations, sections, details, frames, and covers.
2. **Catch basins**. Include plans, elevations, sections, details, frames, covers, and grates.

C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes in accordance with manufacturer's written rigging instructions.

D. Handle **catch basins and stormwater inlets** in accordance with manufacturer's written rigging instructions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify **Owner** no fewer than **two** days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without the **Owner's** written permission.

PART 2 - PRODUCTS

2.1 CORRUGATED-PE PIPE AND FITTINGS

A. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.

B. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252, Type S, with smooth waterway for coupling joints.

C. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294, Type S, with smooth waterway for coupling joints.

D. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2.2 PVC PIPE AND FITTINGS

A. Source Limitations: Obtain PVC pipe and fittings from single manufacturer.

B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

D. Adhesive Primer: ASTM F 656.

2.3 MANHOLES

A. Standard Precast Concrete Manholes: City of Dayton specification

2.4 CATCH BASINS

A. Standard Precast Concrete Catch Basins: City of Dayton specification

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping in accordance with the following:

1. Install piping pitched down in direction of flow.
2. Install PE corrugated sewer piping in accordance with ASTM D 2321.
3. Install PVC sewer piping in accordance with ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping in accordance with the following:

1. Join corrugated-PE piping in accordance with ASTM D 3212 for push-on joints.
2. Join PVC sewer piping in accordance with ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
3. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants in accordance with ASTM C 891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops **3** inches above finished surface elsewhere unless otherwise indicated.

3.5 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.6 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
   1. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   3. Reinspect and repeat procedure until results are satisfactory.

3.7 CLEANING

A. Clean interior of piping of dirt and superfluous materials. **Flush with water.**

END OF SECTION 334200

GEOTECHNOLOGY

A Universal Engineering Sciences Company

GEOTECHNICAL EXPLORATION
GDRTA BUILDING 705
DAYTON, OHIO

Prepared for:

CHAMPLIN ARCHITECTURE
CINCINNATI, OHIO

Prepared by:

GEOTECHNOLOGY, LLC
CINCINNATI, OHIO

Date:

JULY 29, 2021

Geotechnology Project No.:

J038716.01

SAFETY
QUALITY
INTEGRITY
PARTNERSHIP
OPPORTUNITY
RESPONSIVENESS

GEOTECHNOLOGY
A Universal Engineering Sciences Company

July 29, 2021

Mr. Jay Derenthal
Champlin Architecture
720 E. Pete Rose Way, Suite 140
Cincinnati, Ohio 45202

Re: Geotechnical Exploration
GDRTA Building 705
Dayton, Ohio
Geotechnology Project No. J038716.01

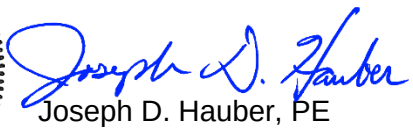
Dear Mr. Derenthal:

Presented in this report are the results of our geotechnical exploration completed for the GDRTA Building 705 project in Dayton, Ohio. Our services were performed in general accordance with our Proposal P038716.01, which was dated April 13, 2021, and signed for authorization on April 22, 2021.

We appreciate the opportunity to provide the geotechnical services for this project. If you have any questions regarding this report, or if we may be of any additional service to you, please do not hesitate to contact us.

Respectfully submitted,
GEOTECHNOLOGY, LLC

Shawn P. Reed, PE
Senior Geotechnical Engineer



Joseph D. Hauber, PE
Principal Geotechnical Engineer

SPR/JDH:spr/jdh

Copies submitted: Champlin Architecture (email)

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GEOTECHNOLOGY
A Universal Engineering Sciences Company

GEOTECHNICAL EXPLORATION
GDRTA BUILDING 705
DAYTON, OHIO
July 29, 2021 | Geotechnology Project No. J038716.01

1.0 INTRODUCTION

Geotechnology, LLC. (Geotechnology) prepared this geotechnical exploration report on behalf of Champlin Architecture (Champlin) for the GDRTA Building 705 project located at the address of 705 Longworth Street in Dayton, Ohio.[1] Our services documented in this report were provided in general accordance with the terms and scope of services described in our Proposal P038716.01, which was dated April 13, 2021, and signed for authorization on April 22, 2021.

The purposes of the geotechnical exploration were: to evaluate the general subsurface profile at the site and the engineering properties of the soils and to develop recommendations for the geotechnical aspects of the design and construction of the project, as defined in our proposal. Our scope of services included a site reconnaissance, geotechnical borings, laboratory testing, engineering analyses, and preparation of this report.

2.0 PROJECT INFORMATION

The following project information was derived from:

- Undated Site Plan, titled “GDRTA Existing Conditions”, which was prepared by LJB, Inc. (LJB), and received electronically on May 4, 2021;
- Memorandum titled “705 Longworth St. Geotechnical Investigation Information for RFP”, which was prepared by Schaefer Structural Engineers (Schaefer) and dated March 31, 2021, and
- Correspondence with Champlin.

We understand that this project will include the construction of canopy structures and below ground tanks for a fueling station north of existing Building 705; a parking canopy for paratransit buses in the existing parking lot west of Building 705; demolition of the northern part of Building 705; a structural repair/replacement of the north bearing wall of the part of Building 705 to remain; and construction of surface parking in the area of the demolished building. Based on the above-mentioned memorandum, it is understood that the new canopies will be cantilever steel structures

[1] GDRTA refers to the Greater Dayton Regional Transit Authority.

with central columns supported on concrete drilled shafts. A layout of the canopy structures along with their foundation loads were not available at the time of this report.

A grading plan has not yet been prepared at the time of this report, but the grading is expected to be relatively minimal based on our understanding of the project and the existing grades.

3.0 SITE CONDITIONS

The site location and regional topography of the area are shown on the Site Location Plan, which is shown as Sheet No. 1 in Appendix B.

The existing property comprises an approximate 3.8-acre tract of land situated within the floodplain of the Great Miami River in an urban business district of Dayton bounded by Veterans Parkway to the west, Longworth Street to the east, an existing GDRTA facility to the north (601 Longworth), and separate isolated GDRTA buildings to the south. The existing structure at 705 Longworth is an irregularly-shaped, 1-story, brick and CMU-block building that encompasses roughly 34,000 square feet in plan area positioned within the southeast quadrant of the subject tract of land. The east, south, and north exterior wall lines were composed of brick, while the west wall line exhibited larger CMU block units. Existing asphalt-paved parking exists to the west and north of the building. A wide concrete-paved service drive extends from Longworth Street to a loading area that exists along the northern wing of the existing building.

Much of the existing property is dominated by relatively flat paved impervious surfaces with limited grass-covered landscaping surrounding the northern parking lot. Given its close proximity to the Great Miami River some 300 to 400 feet away, the site drains to the west, which then empties directly into the Great Miami River. The asphalt parking lots have exhibited significant distress with evidence of numerous alligator cracking, occasional potholes, and overall weathered asphalt that had reduced to sand and gravel-sized fragments in localized areas. The concrete-paved loading zone appeared to be in fair condition with less observed distress. Minor faulting of the concrete slab was noted in a few areas, but the distress was not as great or prevalent as the asphalt pavement. Relative to the building, our observations indicated several areas of stair-stepped cracks in the exterior block walls, which is consistent with the exterior observations noted in the Schaefer memorandum. Our site reconnaissance was generally focused on the existing property west of Longworth Street, though our site observations and review of aerial imagery indicates a relatively large single-story, enclosed brick building on the east side of Longworth Street, which appears to be for the maintenance of GDRTA equipment.

Site conditions were noted and photographed during our reconnaissance. Photographs shown below as Figure 1 and Figure 2 document the condition of the existing paved surfaces while Figure 3 provides a representation of the observed distress along the east exterior wall of the building.

Figure 1. Photograph looking south at the loading dock area of the existing building.

Figure 2. Photograph looking north along the west exterior wall of existing building.

Figure 3. Photograph looking east toward the existing building.

4.0 PROJECT RESEARCH

4.1 Historic Information

The following list of readily available historic information was reviewed for this project:

- USGS Topographic Maps of the Dayton South Quadrangle (1953, 2019), Montgomery County, Ohio; and
- USGS Topographic Map of the Waynesville Quadrangle (1913), Dayton, Ohio

4.2 Previous Geotechnical Explorations

A previous exploration was completed and a geotechnical exploration report prepared by Terracon Consultants, Inc. in 2018 for the GDRTA Building Renovations, located on the east side of Longworth Street. Given its relatively close proximity to the project site, this report was made available to Geotechnology for our use on this GDRTA Building 705 Renovations project.

5.0 SUBSURFACE EXPLORATION

The subsurface exploration initially consisted of six borings (numbered B-1 through B-6), though one boring planned to be drilled along the east side of the existing building (Boring B-6) was omitted prior to our mobilization due to congestion of existing overhead and underground utilities. The boring locations were selected by us and were staked in the field by an LJB survey crew relative to their survey control and benchmark elevation. The locations of the borings are shown on our Boring Plan, which is shown as Sheet No. 2 in Appendix B.

The borings were drilled between April 27 and 30, 2021 with a track-mounted drill rig advancing continuous flight hollow-stem augers, as indicated on the boring logs presented in Appendix C. Sampling of the overburden soils was accomplished ahead of the augers at the depths indicated on the boring logs with a 2-inch-outside-diameter (O.D.) split-barrel sampler in general accordance with the procedures outlined by ASTM D1586. Standard Penetration Tests (SPTs) were performed with the split-barrel sampler to obtain the standard penetration resistance or N-value[2] of the sampled material. Observations for groundwater were made in the borings during and upon completion of drilling.

As each boring was advanced, the Drilling Foreman prepared a field log of the subsurface profile noting the soil and bedrock types and stratifications, groundwater, SPT results, and other pertinent data.

Representative portions of the split-barrel samples were placed in glass jars with lids to preserve the in-situ moisture contents of the samples. The glass jars were marked and labeled in the field for identification when returned to our laboratory.

6.0 LABORATORY REVIEW AND TESTING

Upon completion of the fieldwork, the samples recovered from the borings were transported to our Soil Mechanics Laboratory, where they were visually reviewed and classified by the Project Geotechnical Engineer.

Laboratory testing was performed on selected soil samples to estimate engineering and index properties. Laboratory testing of the selected soil samples included various combinations of the following tests: moisture content, Atterberg limits, and gradation (particle-size) analyses. The results of these tests are summarized in the Tabulation of Laboratory Tests in Appendix D, along with the particle-size analysis forms.

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[2] The standard penetration resistance, or N-value, is defined as the number of blows required to drive the split-barrel sampler 12 inches with a 140-pound hammer falling 30 inches. Since the split-barrel sampler is driven 18 inches or until refusal, the blows for the first 6 inches are for seating the sampler, and the number of blows for the final 12 inches is the N-value, which is reported as blows per foot (or bpf). Additionally, “refusal” of the split-barrel sampler occurs when the sampler is driven less than 6 inches with 50 blows of the hammer.

The boring logs, which are included in Appendix C, were prepared by the Project Geotechnical Engineer on the basis of the field logs, the visual classification of the soil samples in the laboratory, and the laboratory test results. A Soil Classification Sheet is also included in Appendix C, which describes the terms and symbols used on the boring logs. The dashed lines on the boring logs indicate an approximate change in strata as estimated between samples, whereas a solid line indicates that the change in strata occurred within a sample where a more precise measurement could be made. Furthermore, the transition between strata can be abrupt or gradual.

7.0 SUBSURFACE CONDITIONS

7.1 Stratification

Generally, the ground surface was underlain by existing undocumented cohesive and cohesionless fill over native cohesive and cohesionless alluvial soils followed by glacial outwash interbedded with lacustrine soils to the explored depths of the borings. More specific descriptions of the subsurface strata are provided below, and the boring logs containing detailed material descriptions are located in Appendix C.

7.1.1 Pavement

Pavement was encountered in each of the borings drilled for this project. With the exception of Boring B-5, the existing pavement was comprised of 3 to 10 inches of asphaltic concrete over approximately 2 to 3 inches of aggregate base, as summarized below in Table 1. The total pavement section thickness encountered in the borings ranged from 6 to 12 inches with an average thickness just over 7 inches.

Table 1. Summary of pavement thicknesses

Boring	Thickness (inches)			
	AC Concrete (in.)[a]	PC Concrete (in.)[b]	Aggregate Base (in.)	Total (in.)
B-1	10		2	12
B-2	3		3	6
B-3	3		3	6
B-4	6			6
B-5		6		6

[a] AC = Asphaltic Concrete.
[b] PC = Portland Cement.

7.1.2 Fill

Existing undocumented fill was encountered beneath the ground surface in each of the borings and extended to depths ranging from 7 feet (Borings B-1 and B-2) to 12 feet (Borings B-3 through B-5) below existing grade. The existing fill consisted of both cohesive and granular soils. The cohesive fill encountered at the site was described as brown to dark brown, moist stiff to very stiff lean clay with various proportions of gravel, cinders, and other miscellaneous debris. The granular fill was described as brown and dark brown with occasional gray, moist to wet, very loose to medium dense, fine-grained silts and sands and coarse-grained sands and gravels with occasional cinders and brick fragments. It should be noted that the fill in general was highly

variable in composition, density, color, and moisture. Two natural moisture content tests obtained from samples of the fine-grained granular fill were 14.9 and 19.1 percent. Uncorrected SPT N-values of the cohesive fill ranged from 3 blows per foot (bpf) to 15 bpf and averaged approximately 10 bpf, while the SPT N-values in the cohesionless fill ranged from 2 bpf to 19 bpf and averaged 8 bpf. Two hand penetrometer (HP) readings were obtained on the cohesive fill with values ranging from 2.0 to 2.5 tons per square foot (tsf) indicating a stiff to very stiff consistency.

7.1.3 Alluvium

Native alluvial soils were encountered beneath the existing fill in each of the borings, which then extended to depth of approximately 19 feet. Alluvial soils (or alluvium) are sedimentary soils that are deposited by fluvial or flowing water systems (e.g., streams, rivers, etc.). Similar to the existing fill, the alluvial soils encountered at the site included cohesive soils interbedded with granular soils. The cohesive alluvium was described as brown to dark brown and occasional grayish-brown, moist medium-stiff to very stiff silty to lean clay and one fat clay seam. The thickness of the cohesive alluvium ranged from 2.5 feet in Borings B-1, B-3, and B-5 to 10 feet in Boring B-2. The granular alluvium was described as brown to gray, moist to very moist, very loose to medium dense, fine-grained clayey sands and coarse-grained sands. Uncorrected SPT N-values of the cohesive alluvium ranged from 5 bpf to 9 bpf with an average of about 7 bpf, while the SPT N-values in the granular alluvium ranged from 2 bpf to 14 bpf and averaged 6 bpf. Several HP readings were obtained on the cohesive alluvium with values ranging from 1.0 tsf to 2.5 tsf and averaging about 1.75 tsf, indicating a stiff consistency on average. Natural moisture content tests were performed on representative samples of the cohesive alluvium with results ranging from 25.0 to 38.7 percent and an average of 33.3 percent. Where subjected to classification testing, the cohesive alluvium classified as lean clay (CL) and fat clay (CH) according to the USCS. The results of these classification tests are tabulated below in Table 2 and in Appendix D.

Table 2. Summary of Atterberg limits test results of the alluvium.

	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Minimum	44	23	21
Maximum	55	29	26
Average	50	26	24

7.1.4 Glacial Outwash

Native glacial soils, and occasional interbedded lacustrine soils (discussed below), were encountered beneath the native alluvium and extended to the explored depths of the borings. Glacial soils are soils that have been deposited, transported, or reworked in place by the advancement or retreat of a glacier across the area. In general, the native glacial profile consisted of cohesionless glacial outwash. Glacial outwash is generally associated with the retreat of glaciers. As glacial ice melts, fine sediments, sand, and gravel trapped in the ice are released and settle out as the water flows away from the glacier. The outwash deposits also are derived from the erosion of the meltwater streams.

The glacial outwash consisted of brown to gray, medium to very dense, fine to coarse sands and gravels with various proportions of silt and clay. With the exception of three SPT samples that encountered sampler refusal conditions, uncorrected SPT N-values recorded in the glacial outwash ranged from 23 bpf to 76 bpf with an average of about 40 bpf, indicative of a dense condition on average. One natural moisture test was performed on a representative sample of the glacial outwash with a result of 23.4 percent. The glacial outwash was classified in the laboratory as either well-graded gravel with silt (GW-GM) or poorly-graded sand with silt (SP-SM). The classification test results of the glacial soils are tabulated below in Table 3 and in Appendix D.

Table 3. Glacial soil classification test results

Boring	Sample	Gradation Analysis (%)				USCS Classification[a]
		Gravel	Sand	Silt	Clay	
B-2	SS-9	46.8	44.2	9.0		GW-GM
	SS-13	0.4	89.6	10.0		SP-SM

[a] On samples where Atterberg limits tests were not performed, the proportion of fines were assumed to primarily consist of silt in determining the USCS classification.

7.1.5 Lacustrine Soils

Lacustrine soils were encountered as two separate layers interbedded with the glacial outwash in Boring B-2, one at a depth of 53 feet and another that extended from a depth of 73 feet to the explored depth of the boring. Lacustrine (or lakebed) soils are sedimentary soils that are deposited in quiescent lakes, which produce fine horizontal laminations that are characteristic of these soils. Where fully penetrated, the thickness of this layer was approximately 5 feet. The lacustrine soils in this boring were described as grayish-brown, very moist, stiff to very stiff lean to silty clay with occasional laminations of sand and silt based on visual observations and/or laboratory test results as tabulated below in Table 4. Uncorrected SPT N-values of the lacustrine soils ranged from 53 bpf to 89 bpf with an average of about 71 bpf. Three HP readings were obtained in this layer with values ranging from 2.0 to 4.5 tsf indicating a stiff to hard consistency

Table 4. Lacustrine classification test results

Boring	Samples	Atterberg Limits (%)			Gradation Analysis (%)				USCS Class
		LL	PL	PI	Gravel	Sand	Silt	Clay	
B-2	20 – 21	23	19	4	11.3	16.4	72.3		CL-ML

7.2 Groundwater Conditions

As mentioned in Section 5.0, groundwater observations were made in the borings during and upon completion of drilling. These measurements are documented on the boring logs in Appendix C and are summarized below in Table 5.

Table 5. Summary of groundwater observations.

Boring	Elevation (feet)			
	Boring		Water Level	
	Top	Bottom	During Drilling[a]	Upon Completion[a]
B-1	741.3	704.8	711.3	704.8
B-2	740.2	658.7	710.2	NE[b]
B-3	739.6	703.1	714.6	
B-4	739.2	702.7	709.2	702.7
B-5	736.6	700.1	706.6	700.6

[a] Abbreviation: NE = not encountered.
[b] Note that drilling mud was added down the hollow stem augers to prevent heaving of sands after encountering groundwater at 30.0 feet in Boring B-2.

Based on the groundwater observations and our local experience, groundwater seepage is anticipated along the fill/native soil interface and in the saturated zones of fill or native soils that are either within perched groundwater zones or below the groundwater table. Locally concentrated flow may occur due to saturated layers of fill or native soils (particularly the native alluvial and glacial silts, sands, or gravels). Groundwater levels are anticipated to fluctuate with rises and falls in the Great Miami River due to the close proximity of this river and the cohesionless soils encountered in the borings; however, these rises and falls may have a delayed response to the river levels. Additionally, groundwater levels and seepage amounts are expected to vary with time, location, season of the year, and amounts of precipitation.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on our engineering reconnaissance of the site, the borings, the visual examination of the recovered samples, the laboratory test results, our understanding of the proposed project, our engineering analyses, and our experience as Geotechnical Engineers in the Greater Dayton Area, the following conclusions and recommendations are presented.

8.1 Excavation Support

Excavation support should be the responsibility of the Contractor. Excavation support should be designed and implemented such that excavations are adequately ventilated and braced, shored, and/or sloped in order to protect and ensure the safety of workers within and near the excavations and to protect adjacent ground, slopes, structures, and infrastructure. Federal, state, and local safety regulations should be satisfied. The analyses, discussions, conclusions, and recommendations throughout this report are not to be interpreted as pre-engineering compliance with any safety regulation.

8.2 Site Preparation and Earthwork

As stated in Section 2.0, earthwork for this project will be minimal and likely limited to the removal and/or rehabilitation of the existing pavements.

Where applicable, the initial preparation of the site for grading should include the removal of vegetation, heavy root systems, and topsoil from the proposed cut, fill, pavement, and structure areas. The topsoil may be stockpiled for future use on the completed cut and fill slopes or in landscaped areas, if permitted by specification, whereas the vegetation, including the heavy root systems, should be disposed of off-site in accordance with applicable regulations.

Existing structures and pavements within the grading and proposed structure limits should be demolished, and the foundations removed. Concrete, asphalt, rubble, and debris associated with those structures and pavements should be disposed of off-site, unless there are provisions in the specifications for on-site reclamation of these materials. We should be retained to review these provisions to evaluate their impact on the recommendations of this report. Pavements outside of the footprints of the proposed structures may temporarily be left in place prior to removal and/or replacement to provide a stable base for construction equipment. The existing undocumented fill is highly variable in composition, density, and moisture. As such, it is generally considered unsuitable for the support of pavements, new fill, and structures in its current condition. However, since the undocumented fill extends to depths ranging from 7 to 12 feet deep, it may not be cost effective to remove it in its entirety when the foundation support for the proposed structures can be addressed separately. In this case, the undocumented fill may remain in place provided that the existing subgrade is deemed acceptable upon completion of a successful proofroll as defined below and provided that the foundations for the proposed load-bearing structures are installed in accordance with the recommendations presented in Section 8.4.

After the above operations and making required excavations in cut areas, the exposed subgrade should be thoroughly proofrolled using a loaded tandem-axle dump truck weighing at least 40,000 pounds under the review of the Project Geotechnical Engineer, or a representative thereof. Soft or yielding soils observed during the proofrolling should be undercut to stiff, non-yielding, cohesive soils or medium dense to dense, well-graded, cohesionless soils; the depth of undercut below proposed subgrade may be limited to 4 feet.

Where undercuts are performed, the excavations should be backfilled with new compacted fill satisfying the material and compaction requirements presented in this section. The undercut soils may be reused provided that they conform to the recommendations contained in this report regarding acceptable fill materials. We recommend that the Contract Documents include a bid item for the recommended undercutting, as deemed necessary, and their replacement with new compacted and tested fill on a “per cubic yard of in-place compacted fill” basis.

If soft or yielding soils are encountered at the maximum undercut depth specified above and the compaction requirements of the undercut backfill cannot be achieved at the bottom of the undercut, the subgrade may be stabilized at those depths using an approved biaxial or triaxial geogrid (e.g., Tensar BX-1200 or TriAx TX160) and an 8-inch lift of compacted crushed stone. The remainder of the undercut should be backfilled with dense-graded aggregate or clayey soils satisfying the material and compaction requirements presented in this section. If clayey soils are used, an approved separation geotextile fabric should be provided at the interface between the crushed stone and the clayey soils.

Fill materials should consist of approved on-site, non-organic, clayey soils, bedrock, or approved borrow material that are relatively free of topsoil, vegetation, trash, construction or demolition debris, frozen materials, particles over 6 inches in maximum dimension, or other deleterious materials.

The fill should be placed in shallow level lifts (or layers), 6 to 8 inches in loose thickness. Each lift should be moisture-conditioned to within the acceptable moisture content range provided in Table 6, and compacted with a sheepsfoot roller or self-propelled compactor to at least the minimum percent compaction indicated in the same table. Moisture-conditioning may include: aeration and drying of wetter soils; wetting of drier soils; and/or thoroughly mixing wetter and drier soils into a uniform mixture.

Table 6. Percent compaction and moisture-conditioning requirements for fill and backfill.

Area	Minimum Percent Compaction[a,b]	Acceptable Moisture Content Range[c]
Structural[d]	98% of SPMDD	-2% to +3% of OMC
Non-structural	95% of SPMDD	±3% of OMC
Floor slab subgrade	98% of SPMDD	0% to +3% of OMC
Pavement subgrade: ≤ 8 inches below subgrade	98% of SPMDD	±2% of OMC

[a] SPMDD = standard Proctor maximum dry density determined from ASTM D698.
[b] For granular soils that do not exhibit a well-defined moisture-density relationship, refer to Table 11 for minimum relative density requirements.
[c] OMC = optimum moisture content determined from ASTM D698.
[d] Structural fill and backfill for foundations are defined as fill and backfill located within the zones of influence of structures. The zone of influence of a structure is defined as the area below the footprint of the structure and 2H:1V outward and downward projections from the bearing elevation of the structure.

Groundwater is not expected to have a significant adverse effect on the proposed construction; however, the Contractor must be prepared to remove seepage that accumulates in excavations, on fill surfaces, or at subgrade levels.

Maintaining the moisture content of bearing and subgrade soils within the acceptable range provided in Table 6 is very important during and after construction for the proposed structures. The clayey bearing and subgrade soils should not be allowed to become excessively wet or dried during or after construction, and measures should be taken to prevent water from ponding on these soils and to prevent these soils from desiccating during dry weather.

Positive drainage should be established around the proposed structures to promote the rapid drainage of surface water away from these structures and to prevent the ponding of water adjacent to these structures. Finish grading in grass and landscaped areas should be sloped down and away from the structures at 10 percent for at least 10 feet, and then at a gradient of at least 2 percent beyond the initial 10 feet from the structures. Proposed pavements should drain away from the structures at a minimum of 2 percent. The final grades should direct the surface water to storm water collection systems.

We recommend that the earthwork operations be carried out during the drier season of the year and that a sufficient gradient be maintained at the ground surface to prevent ponding of surface water. In our experience, the weather conditions are historically more favorable for earthwork during the months of May through October in the Greater Dayton Area. Regardless of the time of year, asphalt, concrete, or fill should not be placed over frozen or saturated soils, and frozen or saturated soils should not be used as compacted fill or backfill.

Best management practices (BMPs) should be implemented to reduce the effects of erosion and the siltation of adjacent properties. Upon completion of earthwork, disturbed areas should be stabilized.

8.3 Seismic Site Classification

Based on the borings and our interpretation of the International Building Code, it is our opinion that Site Class D is applicable for this project site.

8.4 Foundation Design and Construction

Given the relatively heavy foundation loads anticipated in combination with the presence of a relatively thick layer of undocumented fill materials over loose native alluvial sands, both layers of which are considered moderately to highly compressible, we recommend that the proposed new canopy structures and the reconfigured north wall of the building be supported on a series of deep foundation elements that penetrate through the existing fill and native alluvial soils and into the underlying medium dense to very dense cohesionless glacial outwash. Given its proximity to the existing building of unknown foundation support, we recommend that the proposed load-bearing structures be supported by non-displacement, drilled augercast piles or helical piles. Such deep foundations pose less risk of negatively affecting the existing structures in comparison to a driven system, which is a louder installation technique and capable of densifying the existing loose fill and alluvial soils thus increasing the risk of settlement of shallow foundations. Given the presence of groundwater within the underlying alluvial and outwash sands, augercast piles also provide an advantage over drilled shaft foundations, as they are routinely installed under pressure in a variety of soil and groundwater conditions with minimal deviations in installation whereas drilled shaft foundations on this project would require either casing or slurry to stabilize the shaft walls, which would add a significant expense. Helical piles would be advantageous in that it is a drilled system where the pile itself remains in the ground to serve as foundation support and hence not as affected by the influence of groundwater within a borehole. Discussions of the recommended deep foundation options are presented below.

8.4.1 Augercast Piles

Augered cast-in-place piles (also known as augercast piles or ACIP piles) have been evaluated for support of the proposed new canopy structures and new exterior load-bearing wall of the reconfigured building. Table 7 provides allowable axial capacities in compression and tension for individual 16-inch and 18-inch-diameter augercast piles. The allowable capacities in this table are based on providing a factor of safety (FS) of 2.5 for compression and 3.0 for tension, using the groundwater elevations assumed near the top of glacial outwash.

Table 7. Allowable axial augercast pile capacities.

Pile Length (ft.)[a]	Allowable Axial Pile Capacity (k)[b,c]			
	16-inch-diameter Augercast Pile		18-inch-diameter Augercast Pile	
	Compression (FS = 2.5)	Tension (FS = 3)	Compression (FS = 2.5)	Tension (FS = 3)
30	90	45	110	50
35	115	65	135	75
40	140	85	165	95
45	165	105	195	120
50	195	130	220	145

[a] Pile length measured from bottom of pile cap.
[b] Groundwater elevation assumed at El. 720.
[c] Capacities are to be limited to the smaller of the capacities provided in this table and the maximum allowable by code based on the compressive strength of the grout.

The Project Structural Engineer should verify the structural capacity of the piles based on the unfactored service loads and the requirements of the applicable building code, including, but not limited to, the minimum seismic reinforcement requirements for augercast piles, which vary with the seismic design category. If different augercast pile sizes are to be used, or if higher load capacities are required, then Geotechnology should be retained to reevaluate the augercast pile analyses.

8.4.1.1 Group Effects

Because conventional ACIP piles are a drilled foundation system subject to disturbance of the surrounding soil mass during installation, the design of the piles should consider group effects and its impact to the axial capacity of the group. In modeling the response of the entire group of piles, we recommend that the center-to-center spacing should not be less than three pile diameters. Considering the group effects from neighboring piles, the ultimate capacity will be controlled by the presence of cohesionless soils at or near the anticipated bottom of pile cap extending to the anticipated pile tip elevations. Recognizing this condition and based on guidance presented in the *AASHTO LRFD Bridge Design Specifications* (AASHTO 2020), the ultimate capacity of pile groups can be designed using an efficiency factor (η) of 0.8 whether the pile cap will be in firm contact with the ground or not. Therefore, we recommend that the axial capacity of each pile in a group be reduced by applying an efficiency factor (η) of 0.8 when computing the total axial capacity of all piles in a group. This efficiency factor assumes a pile spacing of three pile diameters, a pile arrangement comprised of more than one row, and a predominately cohesionless soil profile along the length of the piles. Consideration could be given to using an efficiency factor of 1.0 where a single pile or single row of piles will be used, or where the pile spacing is greater than 4 times the pile diameter.

Uplift may be checked on the basis of guidance presented in AASHTO 2020. Considering cohesionless soils were predominately encountered below the ground surface, the allowable uplift

capacity of a group of piles may be computed based on the lesser of: (1) the sum of individual pile capacities in a group, considering the efficiency factor and factor of safety noted above, or (2) the uplift capacity of a block of soil defined by a 1H:4V projection up from the base of the pile group to the elevation of the bottom of pile cap all around. The uplift capacity of a pile group embedded in cohesionless soils is based on the weight of the block of soil itself considering buoyant unit weights below the static groundwater level. A factor of safety of 2.0 should be applied to the ultimate block weight. Refer to Table 8 and Figure 4 for the computation of the soil block in resisting uplift in a pile group.

Table 8. Recommended unit weights in computing the uplift of a soil block.

Elevation	Unit Weight (pcf)
Above 727.5	120
727.5 – 720	110
Below 720	62.6

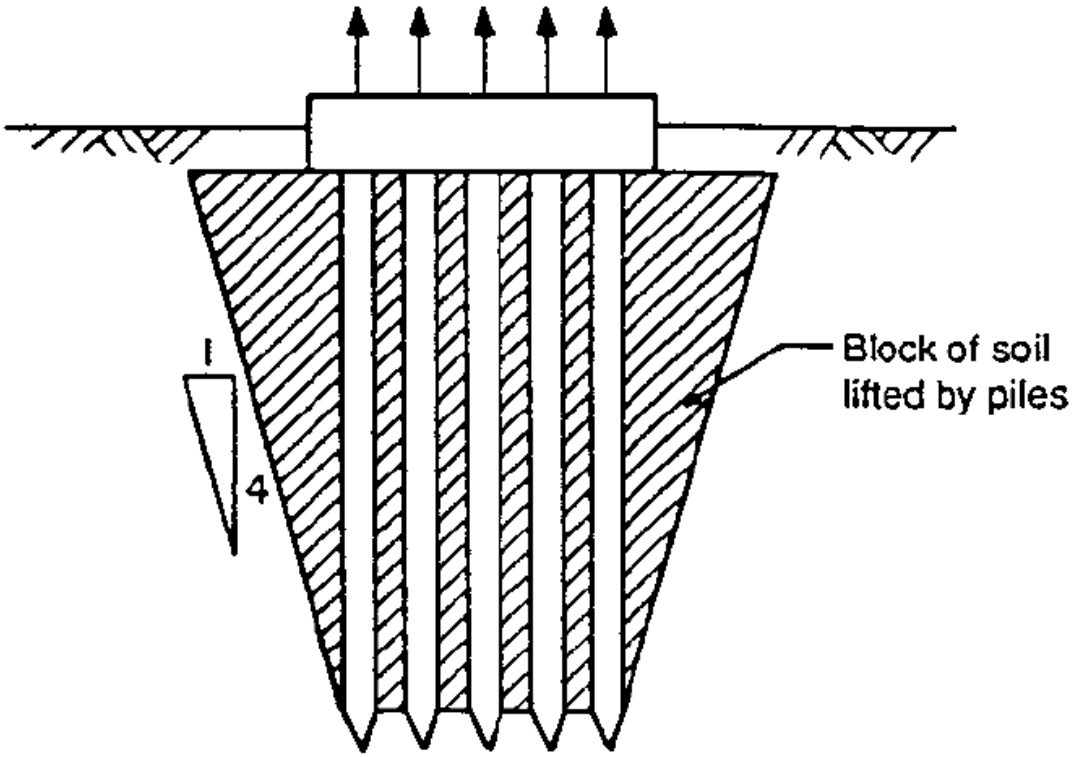


Figure 4. Definition of soil block in computing uplift capacity (Figure 10.7.3.11-1 from AASHTO 2020).

8.4.1.2 Lateral Pile Capacity

Where piles will be supporting lateral loads, we recommend that the response of the piles to these lateral forces be evaluated using p-y soil-structure interaction theory (LPILE) in accordance with the recommended parameters provided in Table 9.

Table 9. Recommended design parameters for p-y analyses of laterally loaded shafts

Elevation (ft.)	Layer	p-y Curve Model	γ (pcf)	s_u (psf)	ε_{50}	ϕ (°)	k (pci)
Above 727.5	FILL	Soft Clay	120	375	0.02		
727.5 – 720	ALLUVIUM	Reese Sand	110			28	10
Below 720	OUTWASH		62.6			40	60

[a] Definitions:
γ = unit weight, s_u = undrained shear strength, ε_{50} = strain at 50% stress
ϕ = angle of internal friction, k = initial horizontal modulus of subgrade reaction

When conducting lateral analyses, please note that where the spacing of laterally loaded deep foundations will be close enough that their areas of resistance overlap, we recommend that an appropriate p-multiplier be applied in the analyses to account for the overlap and reduction in lateral resistance. For piles spaced closer than 3.75 times the pile diameter and where the direction of pile spacing will be perpendicular to the load direction, we recommend that the p-multiplier (p_m) be defined by the empirical relationship presented in Reese et al. (2006):

$$p_m = 0.64(S/D)^{0.34} \leq 1.0$$

where S is the pile spacing and D is the pile diameter or width. For piles where the direction of pile spacing will be parallel to the load direction, the p-multipliers should be per Table 10.7.2.4-1 from the *AASHTO LRFD Bridge Design Specifications* (AASHTO 2020).

8.4.1.3 Augercast Pile Construction and Monitoring Considerations

The augercast piles should be installed by a prequalified Contractor experienced in the installation of augercast piles. To apply for prequalification, the Contractor should submit a list of augercast pile projects completed in the past 5 years. At least three of the listed augercast pile projects should be of equivalent difficulty and/or scope as this project. No Contractor should be considered acceptable without a minimum of 5 years of experience in this type of pile installation.

It is recommended that the Contract Documents for the augercast piles be lump sum based upon the total length estimated from the data contained in this report. Additional add and deduct items per foot of pile should also be included in the contract for deviations from the total estimated lengths of piles.

The augercast piles should be installed with proper, well-maintained equipment capable of drilling straight and plumb to the necessary depths, and then maintaining continuous high grout pressure during the withdrawal of the auger to prevent any “necking” of the grout column. The auger should be slowly rotated during withdrawal and grouting. The installation should be sequenced so that no pile is drilled within 6 pile diameters (center-to-center) of a nearby pile filled with grout less than 24 hours old.

Experience indicates that high pressure grouting through side discharge portals at the tip of the hollow stem auger tends to scour soils along the sides of the holes. The scoured soils then tend to swirl back into and contaminate the grout, which compromises the structural integrity of the pile. This contamination can cause structural failure of the pile at a load less than the design load.

For this reason, it is strongly recommended that the piles be installed using a bottom center discharge auger to reduce the possibility of grout contamination due to side scour. The specifications should include an item to this effect.

Undocumented fill is known to exist on site. In the event that auger refusal is encountered within 10 feet of the proposed bottom of pile cap elevation, the obstruction should be removed with an excavator, the excavation should be restored with compacted structural fill in accordance with the Project Specifications, and then the pile restarted. If an obstruction is encountered more than 10 feet below the bottom of pile cap elevation, but above the design tip elevation, the pile should be abandoned and grouted from the refusal point to 1 foot below the bottom of the pile cap elevation. It is recommended that the Contractor be paid for that footage at the same unit rate as the production piles. Where refusal is encountered, the Project Geotechnical Engineer and Structural Engineer should be advised, and replacement piles and/or reconfigured pile caps should be designed. The intention is to pay the Contractor for unforeseen conditions when constructing the piles at the design location.

We recommend that production piles not be accepted if any of the following conditions occur:

1. The design pile reinforcement cannot be placed manually in the pile following the completion of grouting.
2. The trap door at the bottom discharge outlet fails to open completely, effectively creating a side discharge condition.
3. Loss of grout head occurs for any reason during pile installation.
4. There is more than a 20-minute delay during grouting of any individual pile.
5. There is a drop of grout level after completion of the pile, which exceeds the average of the other pile installations by 2 feet or more.
6. There is a rise in the grout level of any amount.
7. The volume of grout installed in any pile is less than 125 percent of the theoretical volume of the augered hole.

In the event that any of these conditions occur, it will be necessary to redrill and regrout the individual pile for the pile to be considered acceptable as a production pile. The redrilling and the regrouting should be included in the original cost of the pile installation and should not be considered an extra.

The installation of the augercast piles should be reviewed by the Project Geotechnical Engineer, or a representative thereof, in order to confirm that the installation of the piles is consistent with the intent of the Project Specifications. The review should include confirmation of pile lengths, grouting pressures, grout volume, rate of auger withdrawal, changes in levels of completed grout columns, and installation of design reinforcement.

8.4.2 Helical Piles

Helical piles are also considered to be an appropriate foundation system for the existing site and subsurface conditions. Such piles consist of a steel shaft with round helix plates that provide foundation support. When the pile is rotated into the ground, the helix plates generate an axial thrust causing the pile to advance into the ground much like a screw into wood.

We anticipate that helical piles can be designed for allowable axial compression and uplift capacities of 45 and 20 kips, respectively, assuming a dual 10-inch diameter helix followed by a 12-inch diameter helix that penetrates into the medium dense to dense outwash. We recommend that the uppermost helix extend at least 2 feet into the outwash (i.e., at least 22 feet below existing grades). However, a Specialty Contractor should be consulted for the actual arrangement of the helices and determining the required torque to meet the project capacity and the minimum embedment into the outwash. The Specialty Contractor should coordinate with the Structural Engineer on the tolerable settlement. Additionally, the Specialty Contractor should coordinate with the Structural Engineer with regards to eccentric loads on the helical piles and the connections to the existing foundations.

Underpin excavations for the connection of the helical piles to the existing foundations should be limited in length to maintain stability and avoid undermining of the existing foundations.

We recommend that one static axial compression pile load test be performed for this project prior to the installation of the production piles near Boring B-2. The pile should be tested to a minimum of 2 times the maximum allowable design load.

The axial compression pile load test should be accomplished in accordance with ASTM D1143-07, Paragraph 8.1.2, “Procedure A: Quick Test”. The reaction frame should be capable of a safe compression test load equal to at least 3 times the selected design load. The load test should be performed by the Specialty Contractor and observed during testing by the Project Geotechnical Engineer, or representative thereof.

We recommend that the helical pile design be reviewed by Geotechnology prior to implementation to evaluate conformance with the conclusions and recommendations of this report.

8.5 Buoyancy

Based on a 100-year flood elevation of El. 736, roughly 5 feet or less beneath existing grades, in combination with a predominately granular soil profile, we recommend that the proposed below-grade tanks associated with the fueling station be designed to resist buoyant uplift forces. For design against uplift, the groundwater level should be assumed at the ground surface surrounding the structure, and the floodwater level should be assumed at the design flood elevation.

Resistance to buoyant uplift may be provided by a combination of the dead weight of the tank, the buoyant unit weight of the backfill over the tank, and the soil friction around the tank.

For these analyses, the buoyant unit weight of the soil should be 47.6 pcf. Additionally, for the soil friction, an ultimate coefficient of static friction of 0.49 should be used. The normal force for these analyses should be determined from at-rest pressures based on submerged equivalent fluid weight of 27 pcf. A minimum factor of safety of 1.5 should be applied to the resistance to buoyant uplift using the above mechanism.

8.6 Lateral Earth Pressures

Where foundation and retaining walls for this project will be subjected to unbalanced lateral earth pressures, we recommend that the lateral earth pressures be computed on the basis of equivalent fluid weights of the backfill, plus surcharges for foundation loads, pavement loads, sloping backfill, etc. Table 10 provides the recommended equivalent fluid weights for soil for both drained and undrained conditions, and also the recommended earth pressure coefficients for proposed surcharges. Unless a site-specific analysis is performed, we recommend that surcharges be modeled as a uniform horizontal pressure equal to the vertical intensity of the surcharge multiplied by the recommended lateral earth pressure coefficient.

Table 10. Lateral earth pressures for level (horizontal) ground surfaces.

	Active[a]	At-Rest[a]	Passive[a,b]
Lateral earth pressure coefficient, K	0.39	0.56	2.56
Drained equivalent fluid weight, EFW (pcf)	47	67	307
Undrained equivalent fluid weight, EFW_u (pcf)[c]	85	95	210

[a] Parameters are based on level ground surfaces, a soil unit weight (γ) of 120 pcf, and a soil internal angle of friction (ϕ) of 26 degrees.

[b] Passive resistance may be considered where concrete is cast against free-standing vertical faces of soil; however, passive resistance should be ignored in the upper 30 inches below proposed grade due to seasonal variations in moisture and frost penetration. If the ground is sloping down and away from the foundation in the area of passive resistance, we should be contacted to provide site-specific recommendations.

[c] Includes hydrostatic pressure of 62.4 pcf.

The values provided in Table 10 assume that the ground surface adjacent to the wall is level and not sloping toward the wall. For ground sloping toward the wall on its active or at-rest side, we recommend that it be accounted for as a surcharge on the wall, as discussed above, unless site-specific equivalent fluid weights are computed on the basis of the backfill slope.

The decision to use active or at-rest earth pressures should be based upon the ability of the wall or structure to deflect as a result of the lateral earth pressures. In cohesionless granular backfill, active earth pressures are assumed to be applicable if the top of the wall is able to deflect a minimum of 0.002 times the height of the wall. In cohesive clayey backfill, the minimum deflection at the top of the wall for active earth pressures to develop is 0.02 times the height of the wall. If these minimum horizontal deflections at the top of the wall are restrained from occurring or unacceptable to the structure, at-rest earth pressures are applicable.

Undrained equivalent fluid weights should be used in computing the lateral loads on the wall wherever the backfill is unable to be drained by a drainage system (discussed below). For the

drained equivalent fluid weights to be applicable, a drainage system should be incorporated along the backfilled face of the wall (i.e., the high side of the wall) consisting of either a prefabricated drainage board or an approximately 18-inch width of free-draining gravel with less than 3 percent fines wrapped with a non-woven drainage geotextile. At the base of the drainage board or free-draining gravel should be a minimum 12-inch-thick by 12-inch-wide, free-draining gravel zone wrapped with a non-woven drainage geotextile. Within the wrapped gravel at its base should be a 4-inch-diameter rigid perforated plastic pipe. The plastic pipe should be connected to a suitable gravity outlet (e.g., the proposed storm sewer system). The granular backfill should be compacted to at least 75 percent relative density per ASTM D4253 and D4254. We recommend that the drainage system extend to subgrade elevation beneath pavements or floor slabs; otherwise, the drainage system should extend to within 2 feet of finished grade and be capped with at least 2 feet of compacted clayey soils to reduce the infiltration of surface water behind the wall. Clayey backfill should be compacted per the requirements presented in Table 6. The drainage system should not connect to interior drainage systems below floor slabs. These interior drainage systems should have separate, independent outlets.

8.7 Utility Construction

We anticipate that select granular backfill will be used as pipe bedding and pipe zone backfill for the utilities. We recommend that the granular backfill be limited to the pipe bedding and minimum required pipe/utility cover. The remainder of the utility trenches should be backfilled with flowable fill or compacted clayey soils up to design subgrade elevation to reduce the potential for water collecting in these trenches and being absorbed by the surrounding clays, causing heave of foundations, slabs, pavement, etc.

Granular bedding and backfill that exhibits a well-defined moisture-density relationship should be compacted and moisture-conditioned per the requirements presented in Table 6; otherwise, the granular material should be compacted to at least the minimum relative densities indicated in Table 11.

Table 11. Relative density compaction requirements for granular fill and backfill.

Area	Minimum Relative Density[a,b]
Structural[c]	80%
Non-structural	75%
Floor slab and pavement subbase	80%

[a] Relative density evaluated on the basis of the maximum and minimum index densities determined from ASTM D4253 and D4254, respectively.
[b] For granular soils that exhibit a well-defined moisture-density relationship, refer to Table 6 on page 11 for minimum percent compaction and moisture-conditioning requirements.
[c] Structural fill and backfill for foundations are defined as fill and backfill located within the zones of influence of structures. The zone of influence of a structure is defined as the area below the footprint of the structure and 2H:1V outward and downward projections from the bearing elevation of the structure.

Utility trench backfill should be placed in 6- to 8-inch-thick lifts with each lift compacted to at least the specified degree of compaction. Under no circumstances should the backfill be flushed in an attempt to obtain compaction.

If flowable fill is used, it should have a design strength of at least 30 psi for stability and not greater than 100 psi for future excavatability.

Prior to placing the bedding and utilities within the utility trench, soft, saturated, and compressible material should be removed from the bottom of the trench, exposing moist stiff soils or undisturbed bedrock.

8.8 Pavement Design and Construction

Pavements for this project should be designed in accordance with expected axle loads, frequency of loading, and the properties of the subgrade. A California Bearing Ratio (CBR) value of **3** should be assumed in the pavement design for subgrade prepared per the recommendations in this report.

As previously mentioned in Section 8.2, proposed pavement subgrades should be proofrolled with loaded tandem-axle dump truck weighing at least 40,000 pounds under the review of the Project Geotechnical Engineer, or representative thereof. Soft or yielding soils observed during the proofroll should be undercut to stiff, non-yielding soils; however, the depth of undercut below subgrade may be limited to 3 feet in light-duty traffic areas and 4 feet in heavy-duty traffic areas. The undercut should be backfilled with new compacted fill satisfying the material and compaction requirements presented in Section 8.2. We recommend that the Contract Documents include an item for undercutting unsuitable soils and replacing them with new compacted and tested fill on a “per cubic yard of compacted replacement fill” basis.

If soft or yielding soils are encountered at the maximum undercut depths specified above (i.e., 3 feet for light-duty traffic and 4 feet for heavy-duty traffic) and the compaction requirements of the undercut backfill cannot be achieved at the bottom of the undercut, the subgrade may be stabilized at those depths using a biaxial or triaxial geogrid (e.g., Tensar BX-1200 or TriAx TX160 or equivalent) and an 8-inch lift of compacted crushed stone. The remainder of the undercut should be backfilled with dense-graded aggregate or clayey soils satisfying the material and compaction requirements presented in Section 8.2. If clayey soils are used, a separation geotextile should be provided at the interface between the crushed stone and the clayey soils.

In lieu of undercutting soft or yielding soils to the maximum undercut depths specified above (i.e., 3 feet for light-duty traffic and 4 feet for heavy-duty traffic), the subgrade may be stabilized using a biaxial or triaxial geogrid (e.g., Tensar BX-1200 or TriAx TX160 or equivalent) and at least 12 inches of compacted crushed stone. We recommend that the thickness of undercut and compacted crushed stone be field-evaluated based on the conditions encountered during construction and using a test section. This alternative should also be considered if weather, other site conditions, or the project schedule make earthwork activities with clayey soils impractical.

Prior to the placement of pavement or aggregate base, where provided, we recommend that the top 8 inches of clayey subgrade be scarified and recompacted per the requirements presented in Table 6.

If the proposed pavement section includes an aggregate base, we recommend that caution be exercised so that the proposed aggregate base does not become saturated during or after construction. Water trapped in the aggregate base is capable of freezing, causing it to expand within the voids it occupies. Consequently, ice lenses may form and potentially heave the pavement. Furthermore, the thawing process can soften underlying cohesive subgrades, which reduces the pavement support provided by the subgrade, giving rise to “pumping” of the pavements under loads. Preferably, the aggregate base should be a free-draining material with provisions for draining the base through a system of underdrains.

Surface drainage should be directed away from the edges of proposed or existing pavements so that water does not pond next to pavements or flow onto pavements from unpaved areas. Such ponding or flow can cause deterioration of pavement subgrades and premature failure of pavements. In those areas where exterior grades do not fully slope away from the edges of the proposed pavement, we recommend that edge drains be installed along the perimeter of the pavement.

If dumpsters are utilized at the project site, we recommend that the dumpster be supported on concrete slabs and that the slabs be sized to accommodate the loading wheels of the dumpster truck. The access lane to the dumpster should also be designed for the heavier wheel loads associated with dumpster trucks.

9.0 RECOMMENDED ADDITIONAL SERVICES

The conclusions and recommendations given in this report are based on: Geotechnology’s understanding of the proposed design and construction, as outlined in this report; site observations; interpretation of the exploration data; and our experience. Since the intent of the design recommendations is best understood by Geotechnology, we recommend that Geotechnology be included in the final design and construction process, and be retained to review the project plans and specifications to confirm that the recommendations given in this report have been correctly implemented. We recommend that Geotechnology be retained to participate in prebid and preconstruction conferences to reduce the risk of misinterpretation of the conclusions and recommendations in this report relative to the proposed construction of the subject project.

Since actual subsurface conditions between boring locations may vary from those encountered in the borings, our design recommendations are subject to adjustment in the field based on the subsurface conditions encountered during construction. Therefore, we recommend that Geotechnology be retained to provide construction observation services as a continuation of the design process to confirm the recommendations in this report and to revise them accordingly to accommodate differing subsurface conditions. Construction observation is intended to enhance compliance with project plans and specifications. It is not insurance, nor does it constitute a warranty or guarantee of any type. Regardless of construction observation, contractors, suppliers, and others are solely responsible for the quality of their work and for adhering to plans and specifications.

10.0 LIMITATIONS

This report has been prepared on behalf of, and for the exclusive use of, Champlin Architecture for specific application to the named project as described herein. If this report is provided to other parties, it should be provided in its entirety with all supplementary information. In addition, Champlin Architecture should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. The report is not a bidding document and should not be used for that purpose.

Our scope for this phase of the project did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client. Our scope did not include an assessment of the effects of flooding and erosion of creeks or rivers adjacent to or on the project site.

Our scope did not include: any services to investigate or detect the presence of mold or any other biological contaminants (such as spores, fungus, bacteria, viruses, and the by-products of such organisms) on and around the site; or any services, designed or intended, to prevent or lower the risk of the occurrence of an infestation of mold or other biological contaminants.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the subsurface exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Consequently, subsurface conditions may vary gradually, abruptly, and/or nonlinearly between sample locations and/or intervals.

The conclusions or recommendations presented in this report should not be used without Geotechnology's review and assessment if the nature, design, or location of the facilities is changed, if there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if there is a substantial interruption or delay during work at the site. If changes are contemplated or delays occur, Geotechnology must be allowed to review them to assess their impact on the findings, conclusions, and/or design recommendations given in this report. Geotechnology will not be responsible for any claims, damages, or liability associated with any other party's interpretations of the subsurface data or with reuse of the subsurface data or engineering analyses in this report.

The recommendations included in this report have been based in part on assumptions about variations in site stratigraphy that may be evaluated further during earthwork and foundation construction. Geotechnology should be retained to perform construction observation and continue

its geotechnical engineering service using observational methods. Geotechnology cannot assume liability for the adequacy of its recommendations when they are used in the field without Geotechnology being retained to observe construction.

A copy of "Important Information about This Geotechnical-Engineering Report" that is published by the Geotechnical Business Council (GBC) of the Geoprofessional Business Association (GBA) is included in Appendix A for your review. The publication discusses some other limitations, as well as ways to manage risk associated with subsurface conditions.

REFERENCES

American Association of State Highway and Transportation Officials (2020). *AASHTO LRFD Bridge Design Specifications, 9th Edition.* Washington, D.C.

Reese, L.C., Isenhower, W.M., and Wang, S.T. (2006). *Analysis and Design of Shallow and Deep Foundations*, John Wiley & Sons, Inc., Hoboken, New Jersey.

APPENDIX A – IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL-ENGINEERING REPORT

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

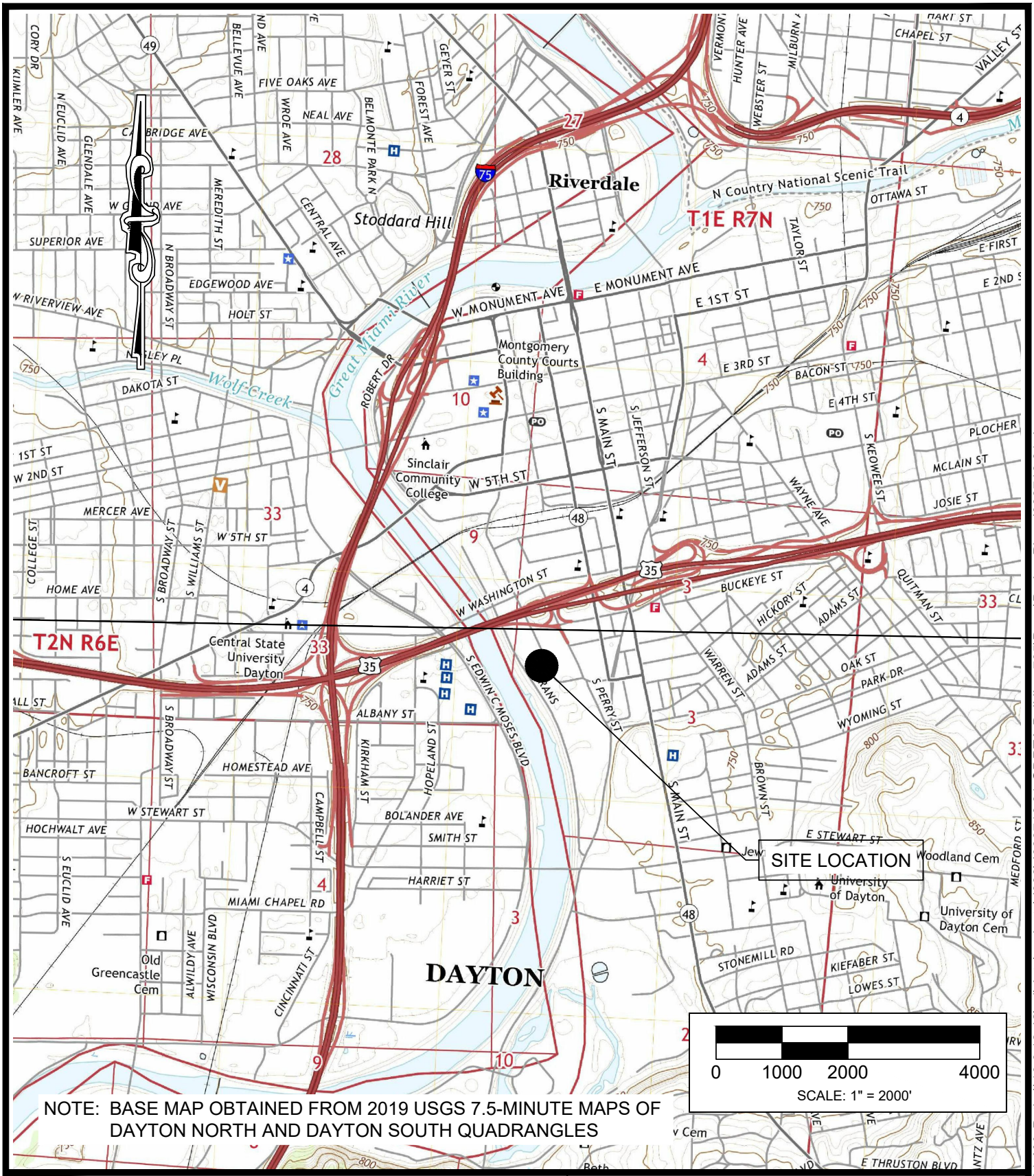
GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX B – PLANS

Site Location Plan, Sheet No. 1

Boring Plan, Sheet No. 2



SITE LOCATION PLAN

GEOTECHNOLOGY

Client:	CHAMPLIN ARCHITECTURE
Project:	GDRTA BUILDING 705
Location:	DAYTON, OH
Date:	7/29/2021
Project No.:	J038716.01
Sheet No.:	1

Date Printed: 7/29/2021 10:01 AM Path: \\10.0.12.42\erl\data\projects\J038\J038716.01-GDRTA Building 705\Draw\Boring Plan-J038716.01.dwg

Date Printed: 7/29/2021 10:01 AM Path: \\10.0.12.42\erl\data\projects\J038\J038716.01-GDRTA Building 705\Draw\Boring Plan-J038716.01.dwg

LONGWORTH STREET

EXISTING BUILDING 705

B-1

B-2

B-3

B-4

B-5

INDICATES TEST BORING LOCATIONS

0 30 60 120

SCALE: 1" = 60'

NOTE: BASE MAP AUTOCAD DRAWING RECEIVED ON 4/26/2021 FROM LJB, INC.

GEOTECHNOLOGY

Project: GDRTA BUILDING 705

Location: 705 LONGWORTH STREET DAYTON, OHIO

Title: BORING PLAN

Client: CHAMPLIN ARCHITECTURE

Date: 7/29/2021

Project No.: J038716.01

Sheet No.: 2

APPENDIX C – BORING INFORMATION

Boring Logs

Soil Classification Sheet

GEOTECHNOLOGY
A Universal Engineering Sciences Company

LOG OF TEST BORING

CLIENT: Champlin Architecture
PROJECT: GDRTA Building 705
Dayton, Ohio
LOCATION OF BORING: As shown on Boring Plan, Drawing Sheet No. 2

BORING #: B-1
PROJECT #: J038716.01
PAGE #: 1 of 1

ELEV.	COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS DESCRIPTION	Strata Depth (feet)	Sample Condition	Sample Number	Sample Type	SPT* Blows/6" / Rock Core RQD (%)	Recovery (in.)	Recovery (%)	HP (tsf)
741.3	Ground Surface	0.0							
740.5	ASPHALT (10 inches)	0.8							
740.3	GRAVEL BASE (2 inches)	1.0	D	1	SS	7-8-11	10	56	
736.8	Dark brown and black moist medium dense SAND and GRAVEL, and CINDERS with brick fragments, glass fragments, carpet, and clay (fill).	4.5	D	2	SS	10-8-7	12	67	
734.3	Dark brown and black moist very loose clayey SAND with cinders and brick fragments (fill).	7.0	D	3	SS	2-2-1	17	94	
	Brown moist to very moist very loose to loose clayey SAND with trace gravel, trace shells (alluvium).		I	4	SS	0-0-2	16	89	1.0
			I	5	SS	4-3-2	14	78	1.25
726.8		14.5	I	6	SS	2-2-2	14	78	1.0
724.3	Dark brown moist stiff LEAN CLAY with oxide stains (alluvium).	17.0	I	7	SS	2-2-3	11	61	1.0
721.8	Orange brown moist loose fine to medium SAND with trace silt and clay (alluvium).	19.5	D	8	SS	3-2-4	14	78	
	Brown slightly moist medium dense to dense silty GRAVEL and fine to coarse SAND (outwash).		D	9	SS	7-10-16	14	78	
713.3		28.0	D	10	SS	13-14-16	14	78	
	Brown slightly wet medium dense to dense silty GRAVEL and fine to coarse SAND (outwash).		D	11	SS	11-12-17	16	89	
704.8		36.5	D	12	SS	22-20-23	15	83	
	Bottom of test boring at 36.5 feet.								

Depth Scale (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Datum: NAVD 88
Surface Elevation: 741.3 ft.
Date Started: 4/27/2021
Date Completed: 4/27/2021
Hammer Weight: 140 lb.
Hammer Drop: 30 in.
Pipe Size: 2 in. O.D.
Hole Diameter: 8 in.
Rock Core Diameter: --
Boring Method: HSA-3.25
Drill Rig: TD-6
Foreman: LRK
Engineer: Joseph D. Hauber

BORING METHOD
HSA = Hollow Stem Augers
CFA = Continuous Flight Augers
DC = Driving Casing
MD = Mud Drilling

SAMPLE TYPE
PC = Pavement Core
CA = Continuous Flight Auger
SS = Split-Spoon Sample
ST = Shelby Tube
RC = Rock Core

SAMPLE CONDITIONS
D = Disintegrated
I = Intact
U = Undisturbed
L = Lost

GROUNDWATER DEPTH
First Noted 30.0 ft.
At Completion 36.5 ft.
After --
Backfilled Immediately

* SPT = Standard Penetration Test - Driving 2" O.D. Sampler 18" with 140-Pound Hammer Falling 30"; Count Made at 6" Intervals

GEOTECHNOLOGY
A Universal Engineering Sciences Company

LOG OF TEST BORING

CLIENT: Champlin Architecture
PROJECT: GDRTA Building 705
Dayton, Ohio
LOCATION OF BORING: As shown on Boring Plan, Drawing Sheet No. 2

BORING #: B-2
PROJECT #: J038716.01
PAGE #: 1 of 2

ELEV.	COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS DESCRIPTION	Strata Depth (feet)	Sample Condition	Sample Number	Sample Type	SPT* Blows/6" / Rock Core RQD (%)	Recovery (in.)	Recovery (%)	HP (tsf)
740.2	Ground Surface	0.0							
739.9	ASPHALT (3 inches)	0.3							
739.7	SAND and BRICK BASE (3 inches)	0.5	I	1	SS	3-6-9	6	33	
737.7	Brown and gray slightly moist medium dense silty GRAVEL and SAND with brick fragments and cinders (fill).	2.5	I/D	2	SS	6-6-7	8	44	
735.7	Brown moist stiff sandy LEAN CLAY with gravel (fill).	4.5	D	3	SS	8-5-5	8	44	
733.2	Brown slightly moist medium dense silty SAND with gravel, trace clay (fill).	7.0	I	4	SS	3-3-6	7	39	1.5
728.2	Dark brown moist stiff to very stiff LEAN CLAY with little sand (alluvium).	12.0	I	5	SS	3-4-5	10	56	2.5
725.7	Dark gray moist stiff FAT CLAY with organic odor (alluvium) (CH).	14.5	I	6	SS	3-4-5	10	56	2.0
723.2	Brown to dark brown moist stiff LEAN CLAY with sand and oxide stains (alluvium) (CL).	17.0	I	7	SS	4-4-4	12	67	
720.7	Brown moist loose fine to coarse SAND with trace silt and clay (alluvium).	19.5	D	8	SS	2-3-4	13	72	
	Brown slightly most dense to medium dense well-graded GRAVEL and SAND with silt (outwash) (GW-GM).		D	9	SS	15-17-17	14	78	
712.2		28.0	D	10	SS	5-6-17	17	94	
	Brown wet dense to very dense silty GRAVEL and SAND (outwash).		D	11	SS	17-17-14	13	72	
702.2		38.0	D	12	SS	26-38-30	15	83	
	Brown wet dense to very dense poorly graded fine SAND with trace gravel and fines (outwash) (SP-SM).		D	13	SS	22-24-25	18	100	
697.2		43.0							
	Brown wet very dense silty GRAVEL and SAND (outwash).								

Depth Scale (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Datum: NAVD 88
Surface Elevation: 740.2 ft.
Date Started: 4/28/2021
Date Completed: 4/28/2021
Hammer Weight: 140 lb.
Hammer Drop: 30 in.
Pipe Size: 2 in. O.D.
Hole Diameter: 8 in.
Rock Core Diameter: --
Boring Method: HSA-3.25
Drill Rig: TD-6
Foreman: LRK
Engineer: Joseph D. Hauber

BORING METHOD
HSA = Hollow Stem Augers
CFA = Continuous Flight Augers
DC = Driving Casing
MD = Mud Drilling

SAMPLE TYPE
PC = Pavement Core
CA = Continuous Flight Auger
SS = Split-Spoon Sample
ST = Shelby Tube
RC = Rock Core

SAMPLE CONDITIONS
D = Disintegrated
I = Intact
U = Undisturbed
L = Lost

GROUNDWATER DEPTH
First Noted: 30.0 ft.
At Completion: See Note
After: --
Backfilled: Immediately

* SPT = Standard Penetration Test - Driving 2" O.D. Sampler 18" with 140-Pound Hammer Falling 30"; Count Made at 6" Intervals

GEOTECHNOLOGY
A Universal Engineering Sciences Company

LOG OF TEST BORING

CLIENT: Champlin Architecture
PROJECT: GDRTA Building 705
Dayton, Ohio
LOCATION OF BORING: As shown on Boring Plan, Drawing Sheet No. 2

BORING #: B-2
PROJECT #: J038716.01
PAGE #: 2 of 2

ELEV.	COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS DESCRIPTION	Strata Depth (feet)	Depth Scale (feet)	Sample Condition	Sample Number	Sample Type	SPT* Blows/6" / Rock Core RQD (%)	Recovery (in.)	Recovery (%)	HP (tsf)
692.2	Brown wet very dense silty GRAVEL and SAND (outwash).	48.0	45	D	14	SS	18-36-50/1"	18	100	
	Brown wet medium dense silty GRAVEL and SAND (outwash).		50	D	15	SS	11-13-15	16	89	
687.2		53.0								
	Grayish brown very moist stiff LEAN CLAY, laminated with sand and gravel seams (lacustrine/outwash).		55	I/D	16	SS	19-25-28	15	83	2.0
682.2		58.0								
	Brown and gray wet very dense clayey SAND and GRAVEL with limestone and shale fragments (outwash).		60	D	17	SS	50/3"	3	100	
			65	I/D	18	SS	50/4"	4	100	
			70	D	19	SS	38-29-47	12	67	
667.2		73.0								
	Grayish brown very moist very stiff SILTY CLAY, partly laminated, with wet silt seams, sand, and gravel dropstones (lacustrine) (CL-ML).		75	I	20	SS	36-23-47	14	78	4.0+
658.7		81.5	80	I	21	SS	38-40-49	12	67	4.0+
	Bottom of test boring at 81.5 feet.		85							
	Note: Drilling mud added down hollow stems to prevent heaving of sands after encountering groundwater at 30.0 ft.		90							

Datum: NAVD 88
Surface Elevation: 740.2 ft.
Date Started: 4/28/2021
Date Completed: 4/28/2021
Hammer Weight: 140 lb.
Hammer Drop: 30 in.
Pipe Size: 2 in. O.D.
Hole Diameter: 8 in.
Rock Core Diameter: --
Boring Method: HSA-3.25
Drill Rig: TD-6
Foreman: LRK
Engineer: Joseph D. Hauber

BORING METHOD
HSA = Hollow Stem Augers
CFA = Continuous Flight Augers
DC = Driving Casing
MD = Mud Drilling

SAMPLE TYPE
PC = Pavement Core
CA = Continuous Flight Auger
SS = Split-Spoon Sample
ST = Shelby Tube
RC = Rock Core

SAMPLE CONDITIONS
D = Disintegrated
I = Intact
U = Undisturbed
L = Lost

GROUNDWATER DEPTH
First Noted 30.0 ft.
At Completion See Note
After --
Backfilled Immediately

* SPT = Standard Penetration Test - Driving 2" O.D. Sampler 18" with 140-Pound Hammer Falling 30"; Count Made at 6" Intervals

GEOTECHNOLOGY
A Universal Engineering Sciences Company

LOG OF TEST BORING

CLIENT: Champlin Architecture
PROJECT: GDRTA Building 705
Dayton, Ohio
LOCATION OF BORING: As shown on Boring Plan, Drawing Sheet No. 2

BORING #: B-3
PROJECT #: J038716.01
PAGE #: 1 of 1

ELEV.	COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS DESCRIPTION	Strata Depth (feet)	Sample Condition	Sample Number	Sample Type	SPT* Blows/6" / Rock Core RQD (%)	Recovery (in.)	Recovery (%)	HP (tsf)
739.6	Ground Surface	0.0							
739.3	ASPHALT (3 inches)	0.3							
739.1	GRAVEL BASE (3 inches)	0.5	I	1	SS	3-7-8	8	44	2.0
737.1	Dark brown and black moist stiff to very stiff sandy LEAN CLAY with gravel and organic odor (fill).	2.5	I	2	SS	2-2-3	10	56	
	Brown moist loose clayey SAND with gravel, brick fragments, cinders, and lean clay layers/pockets (fill).		D	3	SS	2-3-2	6	33	
			D	4	SS	2-3-3	10	56	
727.6		12.0	D	5	SS	2-3-4	6	33	
725.1	Dark brown moist stiff LEAN CLAY, trace sand (alluvium).	14.5	I	6	SS	3-4-5	18	100	
722.6	Brown, trace gray moist loose clayey SAND with trace shells (alluvium).	17.0	I	7	SS	3-2-4	18	100	1.5
720.1	Brown and orange brown moist medium dense fine to coarse SAND with little gravel (alluvium).	19.5	D	8	SS	4-7-7	16	89	
	Brown slightly moist dense silty GRAVEL and SAND (outwash).		D	9	SS	12-20-15	11	61	
711.6		28.0	D	10	SS	15-17-19	6	33	
	Brown wet dense silty GRAVEL and SAND (outwash).		D	11	SS	11-16-17	10	56	
703.1		36.5	D	12	SS	10-15-16	16	89	
	Bottom of test boring at 36.5 feet.								

Depth Scale (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Datum: NAVD 88
Surface Elevation: 739.6 ft.
Date Started: 4/28/2021
Date Completed: 4/28/2021

Hammer Weight: 140 lb.
Hammer Drop: 30 in.
Pipe Size: 2 in. O.D.

Hole Diameter: 8 in.
Rock Core Diameter: --
Boring Method: HSA-3.25

Drill Rig: TD-6
Foreman: LRK
Engineer: Joseph D. Hauber

BORING METHOD
HSA = Hollow Stem Augers
CFA = Continuous Flight Augers
DC = Driving Casing
MD = Mud Drilling

SAMPLE TYPE
PC = Pavement Core
CA = Continuous Flight Auger
SS = Split-Spoon Sample
ST = Shelby Tube
RC = Rock Core

SAMPLE CONDITIONS
D = Disintegrated
I = Intact
U = Undisturbed
L = Lost

GROUNDWATER DEPTH
First Noted 25.0 ft.
At Completion 25.0 ft.
After --
Backfilled Immediately

* SPT = Standard Penetration Test - Driving 2" O.D. Sampler 18" with 140-Pound Hammer Falling 30"; Count Made at 6" Intervals

GEOTECHNOLOGY
A Universal Engineering Sciences Company

LOG OF TEST BORING

CLIENT: Champlin Architecture
PROJECT: GDRTA Building 705
Dayton, Ohio
LOCATION OF BORING: As shown on Boring Plan, Drawing Sheet No. 2

BORING #: B-4
PROJECT #: J038716.01
PAGE #: 1 of 1

ELEV.	COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS DESCRIPTION	Strata Depth (feet)	Sample Condition	Sample Number	Sample Type	SPT* Blows/6" / Rock Core RQD (%)	Recovery (in.)	Recovery (%)	HP (tsf)
739.2	Ground Surface	0.0							
738.7	ASPHALT (6 inches)	0.5							
738.2	BRICK and SAND (fill)	1.0	I	1	SS	4-5-8	12	67	2.5
736.7	Dark brown and brown moist very stiff sandy LEAN CLAY with gravel, trace cinders (fill).	2.5	D	2	SS	5-7-7	14	78	
	Dark brown, black, and brown very moist very loose to loose CINDERS, SAND, GRAVEL, and BRICK FRAGMENTS with lean clay (fill).		D	3	SS	3-2-2	14	78	
			D	4	SS	2-2-2	16	89	
727.2		12.0	D	5	SS	2-3-6	18	100	
724.7	Dark brown moist very stiff LEAN CLAY with trace shells (alluvium).	14.5	I	6	SS	2-1-4	18	100	2.5
722.2	Dark brown and black moist stiff LEAN CLAY with organics and organic odor, trace shells (alluvium).	17.0	I	7	SS	2-2-3	18	100	
719.7	Brown slightly moist loose fine to medium SAND with organic seams (alluvium).	19.5	D	8	SS	2-3-5	14	78	
	Brown slightly moist dense to very dense silty GRAVEL and SAND (outwash).		D	9	SS	9-11-21	16	89	
711.2		28.0	D	10	SS	27-28-43	18	100	
	Brown wet dense to very dense silty GRAVEL and SAND (outwash).		D	11	SS	42-39-16	18	100	
702.7		36.5	D	12	SS	14-20-24	18	100	
	Bottom of test boring at 36.5 feet.								

Depth Scale (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Datum: NAVD 88
Surface Elevation: 739.2 ft.
Date Started: 4/27/2021
Date Completed: 4/27/2021
Hammer Weight: 140 lb.
Hammer Drop: 30 in.
Pipe Size: 2 in. O.D.
Hole Diameter: 8 in.
Rock Core Diameter: --
Boring Method: HSA-3.25
Drill Rig: TD-6
Foreman: LRK
Engineer: Joseph D. Hauber

BORING METHOD
HSA = Hollow Stem Augers
CFA = Continuous Flight Augers
DC = Driving Casing
MD = Mud Drilling

SAMPLE TYPE
PC = Pavement Core
CA = Continuous Flight Auger
SS = Split-Spoon Sample
ST = Shelby Tube
RC = Rock Core

SAMPLE CONDITIONS
D = Disintegrated
I = Intact
U = Undisturbed
L = Lost

GROUNDWATER DEPTH
First Noted 30.0 ft.
At Completion 36.5 ft.
After --
Backfilled Immediately

* SPT = Standard Penetration Test - Driving 2" O.D. Sampler 18" with 140-Pound Hammer Falling 30"; Count Made at 6" Intervals

GEOTECHNOLOGY
A Universal Engineering Sciences Company

LOG OF TEST BORING

CLIENT: Champlin Architecture
PROJECT: GDRTA Building 705
Dayton, Ohio
LOCATION OF BORING: As shown on Boring Plan, Drawing Sheet No. 2

BORING #: B-5
PROJECT #: J038716.01
PAGE #: 1 of 1

ELEV.	COLOR, MOISTURE, DENSITY, PLASTICITY, SIZE, PROPORTIONS DESCRIPTION	Strata Depth (feet)	Sample Condition	Sample Number	Sample Type	SPT* Blows/6" / Rock Core RQD (%)	Recovery (in.)	Recovery (%)	HP (tsf)
736.6	Ground Surface	0.0							
736.1	CONCRETE (6 inches)	0.5							
734.1	Gray dry medium dense silty SAND and GRAVEL (fill).	2.5	D	1	SS	3-5-7	3	17	
			D	2	SS	3-2-2	10	56	
	Brown, little black moist stiff sandy LEAN CLAY with gravel, cinders, organics, glass, plastic, and carpet (fill).		I/D	3	SS	2-1-2	6	33	
729.6		7.0							
727.1	Brown very moist very loose clayey SAND with gravel and oxide stains (fill).	9.5	I	4	SS	2-1-1	8	44	0.5
724.6	Dark brown and black very moist to wet very loose clayey SAND with gravel and cinders (fill).	12.0	I	5	SS	8-2-2	8	44	
722.1	Grayish brown very moist medium stiff to stiff LEAN CLAY with sand, trace shells, organics and organic odor (alluvium).	14.5	I	6	SS	2-2-3	16	89	1.0
719.6	Grayish brown very moist very loose clayey SAND with trace shells, organics, organic odor, and apparent unnatural odor (alluvium).	17.0	I	7	SS	2-1-1	16	89	
717.1	Dark gray moist loose silty fine to medium SAND with trace shells (alluvium).	19.5	D	8	SS	2-2-3	14	78	
	Brown and gray slightly moist dense silty GRAVEL and SAND (outwash).		D	9	SS	11-15-17	16	89	
			D	10	SS	23-16-15	16	89	
708.6		28.0							
	Brown and gray wet dense silty GRAVEL and SAND (outwash).		D	11	SS	17-21-22	18	100	
700.1		36.5	D	12	SS	26-21-23	18	100	
	Bottom of test boring at 36.5 feet.								

Depth Scale (feet): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45

Datum: NAVD 88
Surface Elevation: 736.6 ft.
Date Started: 4/30/2021
Date Completed: 4/30/2021
Hammer Weight: 140 lb.
Hammer Drop: 30 in.
Pipe Size: 2 in. O.D.
Hole Diameter: 8 in.
Rock Core Diameter: --
Boring Method: HSA-3.25
Drill Rig: TD-6
Foreman: LRK
Engineer: Joseph D. Hauber

BORING METHOD
HSA = Hollow Stem Augers
CFA = Continuous Flight Augers
DC = Driving Casing
MD = Mud Drilling

SAMPLE TYPE
PC = Pavement Core
CA = Continuous Flight Auger
SS = Split-Spoon Sample
ST = Shelby Tube
RC = Rock Core

SAMPLE CONDITIONS
D = Disintegrated
I = Intact
U = Undisturbed
L = Lost

GROUNDWATER DEPTH
First Noted 30.0 FT.
At Completion 36.0 FT.
After --
Backfilled Immediately

* SPT = Standard Penetration Test - Driving 2" O.D. Sampler 18" with 140-Pound Hammer Falling 30"; Count Made at 6" Intervals

GEOTECHNOLOGY
A Universal Engineering Sciences Company

SOIL CLASSIFICATION SHEET

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density

Very Loose	- 4 blows/ft. or less
Loose	- 5 to 10 blows/ft.
Medium Dense	- 11 to 30 blows/ft.
Dense	- 31 to 50 blows/ft.
Very Dense	- 51 blows/ft. or more

Relative Properties

Descriptive Term	Percent
Trace	1 – 10
Little	11 – 20
Some	21 – 35
And	36 – 50

Particle Size Identification

Boulders	- 8 inch diameter or more	
Cobbles	- 3 to 8 inch diameter	
Gravel	- Coarse	- 3/4 to 3 inches
	- Fine	- 3/16 to 3/4 inches
Sand	- Coarse	- 2mm to 5mm (dia. of pencil lead)
	- Medium	- 0.45mm to 2mm (dia. of broom straw)
	- Fine	- 0.075mm to 0.45mm (dia. of human hair)
Silt		- 0.005mm to 0.075mm (Cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	Field Identification	Unconfined Compressive Strength (tons/sq. ft.)
Very Soft	Easily penetrated several inches by fist	Less than 0.25
Soft	Easily penetrated several inches by thumb	0.25 – 0.5
Medium Stiff	Can be penetrated several inches by thumb with moderate effort	0.5 – 1.0
Stiff	Readily indented by thumb but penetrated only with great effort	1.0 – 2.0
Very Stiff	Readily indented by thumbnail	2.0 – 4.0
Hard	Indented with difficulty by thumbnail	Over 4.0

Classification on logs are made by visual inspection.

Standard Penetration Test – Driving a 2.0" O.D., 1 3/8" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary to drive the spoon 6 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6 inches of penetration on the drill log (Example – 6/8/9). The standard penetration test results can be obtained by adding the last two figures (i.e. 8+9=17 blows/ft.). Refusal is defined as greater than 50 blows for 6 inches or less penetration.

Strata Changes – In the column "Soil Descriptions" on the drill log, the horizontal lines represent strata changes. A solid line (————) represents an actually observed change; a dashed line (— — — —) represents an estimated change.

Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

APPENDIX D – LABORATORY TEST DATA

Tabulation of Laboratory Tests

Particle-Size Analysis Test Forms

GEOTECHNOLOGY
A Universal Engineering Sciences Company

GDRTA BUILDING 705
705 LONGWORTH STREET
DAYTON, KENTUCKY
J038716.01

TABULATION OF LABORATORY TESTS

Boring No.	Sample No.	Depth (ft.)		Moisture Content (%)	Atterberg Limits (%)			Gradation Analysis (%)				USCS Classification
		From	To		LL	PL	PI	Gravel	Sand	Silt	Clay	
B-1	4	7.5	9.0	24.5								
B-1	7	15.0	16.5	35.1								
B-2	4	7.5	9.0	25.0								
B-2	6	12.5	14.0	36.7	55	29	26					CH
B-2	7	15.0	16.5	31.5	44	23	21					CL
B-2	9	20.0	21.5					46.8	44.2	9.0		GW-GM
B-2	13	40.0	41.5					0.4	89.6	10.0		SP-SM
B-2	16	55.0	65.5	23.4								
B-2	20&21	75.0	81.5	18.8	23	19	4	11.3	16.4	72.3		CL-ML
B-3	5	10.0	11.5	14.9								
B-3	6	12.5	14.0	33.4								
B-3	7	15.0	16.5	26.1								
B-4	6	12.5	14.0	33.8								
B-4	7	15.0	16.5	38.7								
B-5	5	10.0	11.5	19.1								
B-5	6	12.5	14.0	32.4								
B-5	7	15.0	16.5	31.6								

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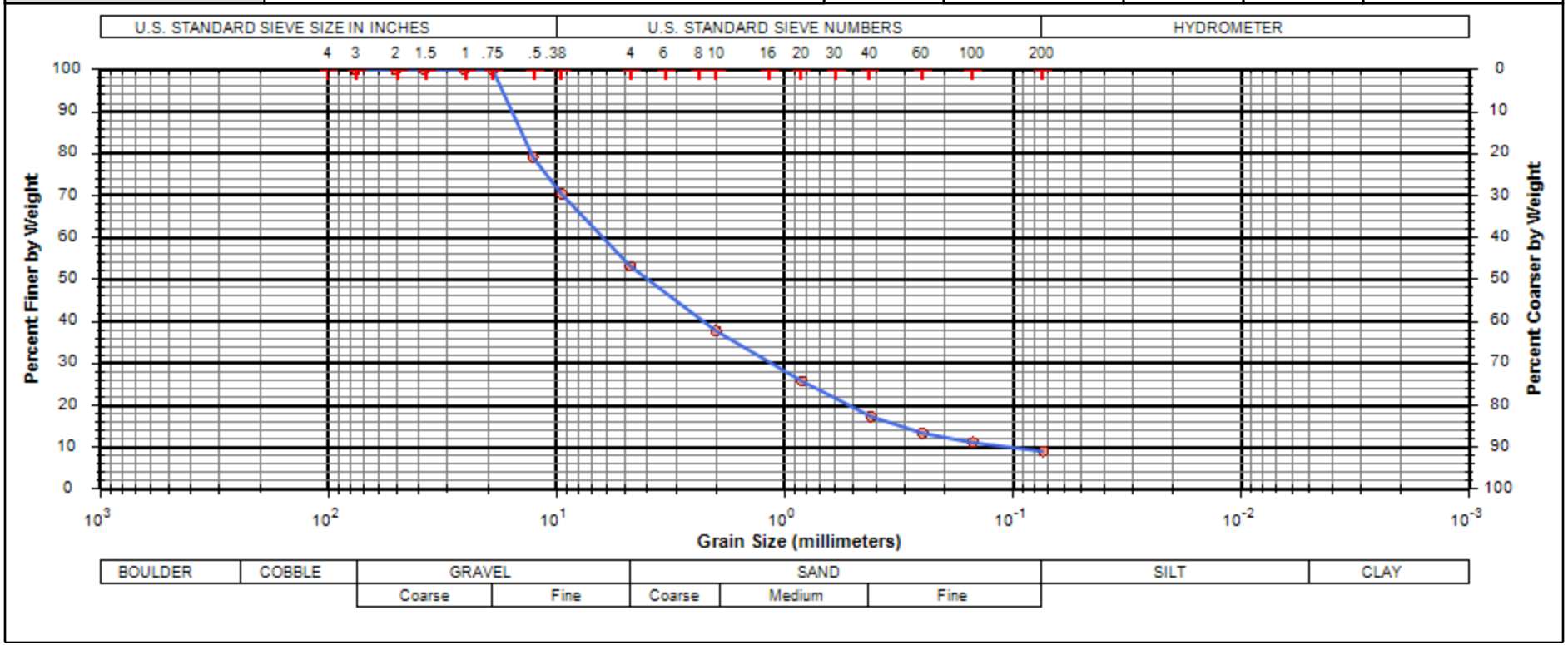
A Universal Engineering Sciences Company

PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422

Client:	Champlin Architecture								**Project No.:**	J038716.01
Project:	Geotechnical Exploration, GDRTA Building 705, Dayton, OH								**Date:**	05/07/2021
Boring No.:	B-2	**Sample No.:**	9	**Depth (ft.):**	20.0 - 21.5	**Gravel (%)**	**Sand (%)**	**Silt & Clay (%)**		**USCS**
Sample Description:	Brown well-graded GRAVEL and SAND with silt (outwash)					46.8	44.2	9.0		GW-GM
						LL	**PL**	**PI**	**Group Index**	**WC (%)**



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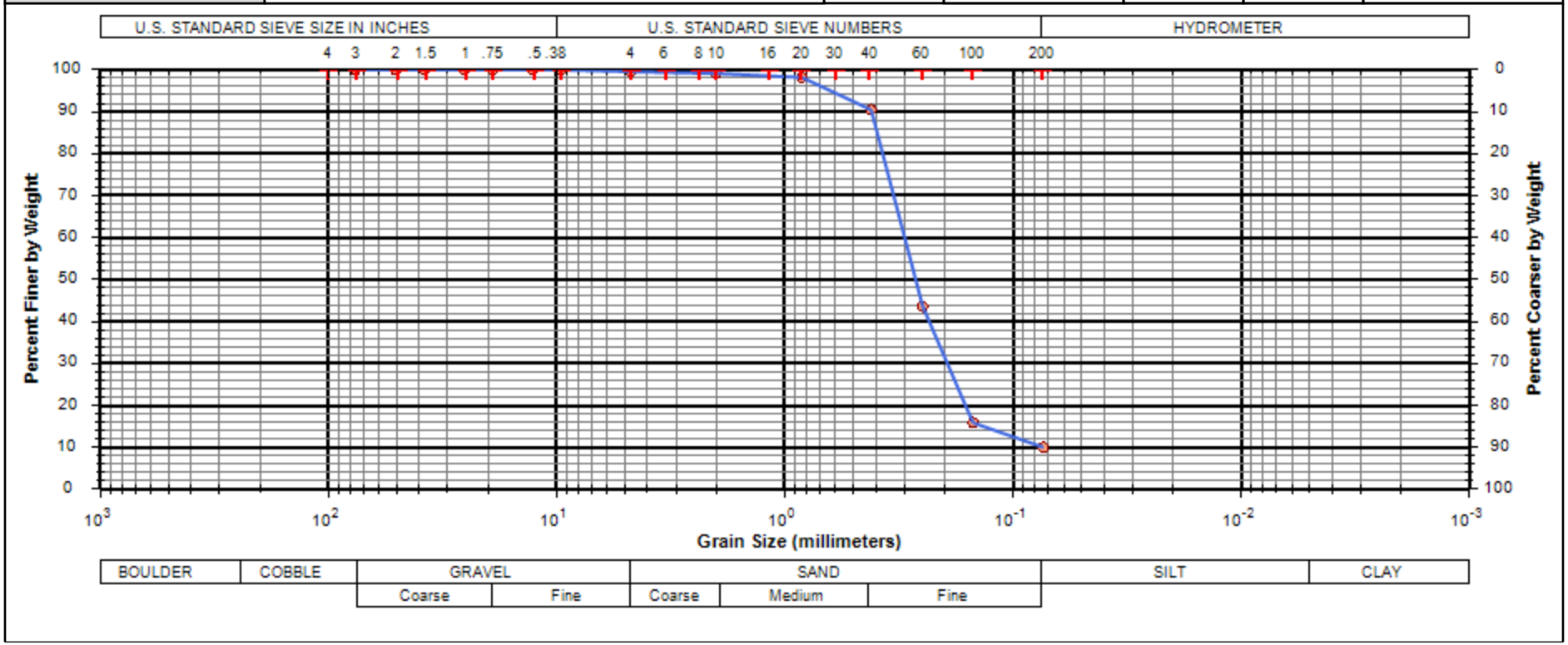
PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422

Client:	Champlin Architecture								**Project No.:**	J038716.01
Project:	Geotechnical Exploration, GDRTA Building 705, Dayton, OH								**Date:**	05/07/2021
Boring No.:	B-2	**Sample No.:**	13	**Depth (ft.):**	40.0 - 41.5	**Gravel (%)**	**Sand (%)**	**Silt & Clay (%)**		**USCS**
Sample Description:	Brown poorly graded fine SAND with trace gravel and fines (alluvium)					0.4	89.6	10.0		SP-SM
						LL	**PL**	**PI**	**Group Index**	**WC (%)**



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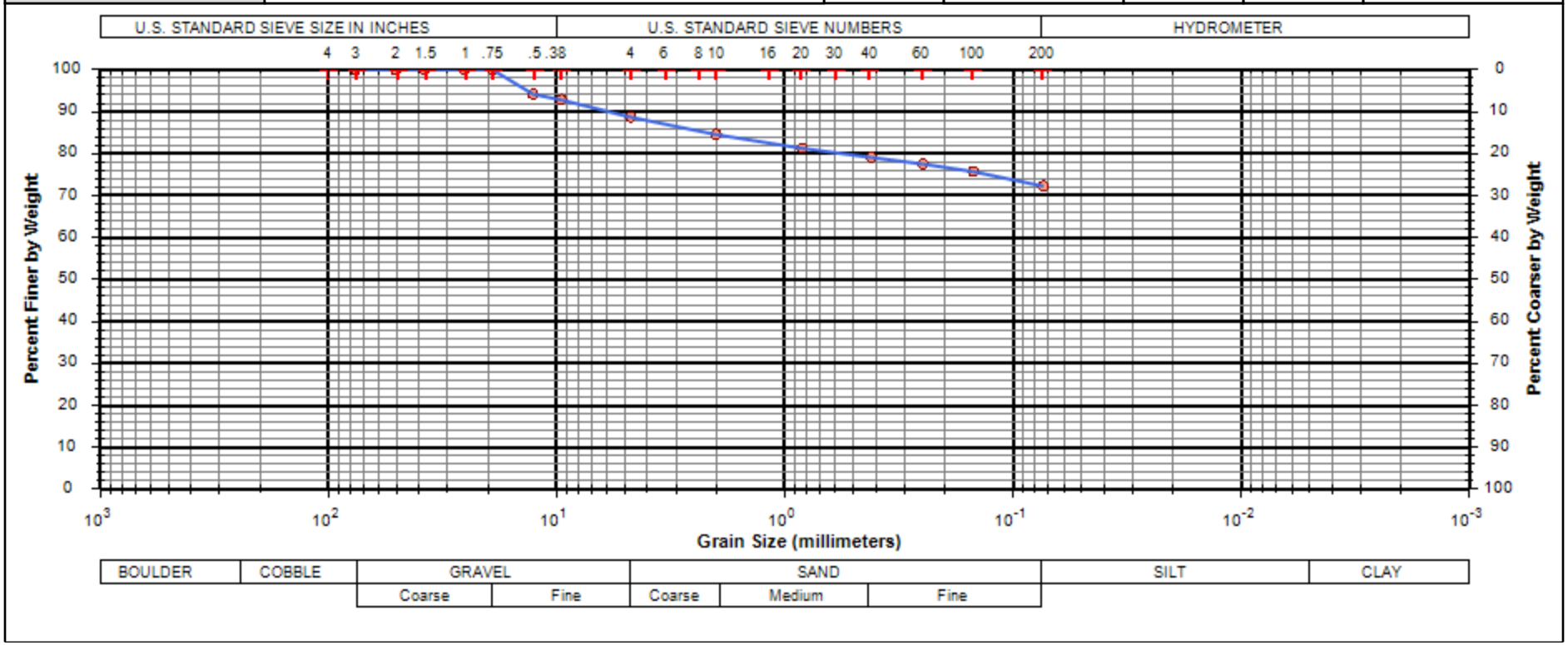
PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422

Client:	Champlin Architecture								**Project No.:**	J038716.01
Project:	Geotechnical Exploration, GDRTA Building 705, Dayton, OH								**Date:**	05/07/2021
Boring No.:	B-2	**Sample No.:**	20 & 21	**Depth (ft.):**	75.0 - 81.5	**Gravel (%)**	**Sand (%)**	**Silt & Clay (%)**		**USCS**
Sample Description:	Grayish brown SILTY CLAY, partly laminated, with sand and gravel dropstones (lacustrine)					11.3	16.4	72.3		CL-ML
						LL	**PL**	**PI**	**Group Index**	**WC (%)**
						23	19	4		18.8



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October 16, 2024

Mr. David Henners, AIA, RIBA
Champlin Architecture
720 E. Pete Rose Way
Cincinati, Ohio 45202

Re: Geotechnical Exploration Report-Addendum No. 1
GDRTA Building 705
Longworth Street, Dayton, Ohio
UES Project No. J038716.02

Dear Mr. Henners:

Geotechnology LLC (dba UES) prepared this Addendum No. 1 to our July 29, 2021, geotechnical report, titled "Geotechnical Exploration, GDRTA Building 705, Dayton, Ohio" (July 2021-Geotechnical Report). This addendum is supplemental to, and to be used in conjunction with, our July 2021 Geotechnical Report.

The project includes the construction of two separate buildings, one for bus garage and another for bus wash and fueling station purposes. The existing GDRTA (Greater Dayton Regional Transit Authority) Building at 705 Longworth Street (Building 705) will be completely demolished as part of the current project plan and the new garage building will be constructed in its place. The existing Building 705 is an irregularly shaped, 1 story, brick and CMU-block building that encompasses roughly 34,000 square feet in plan area. The new garage building will have approximately double plinth area than that of the existing Building 705.

Geotechnology drilled six (6) test borings in 2021 outside the existing building footprint. Due to cost constraints, boring(s) inside the existing building were not performed. Hence, the recommendations presented in the original report assumed that similar subsurface conditions to the exterior borings exist within the footprint of the existing building. No additional borings and laboratory testing were performed to prepare recommendations presented in this addendum.

1.0 PROJECT INFORMATION

The following project information was derived from the following information:

- Correspondence via phone conversation and email with Mr. David Henners (Champlin) since September 17, 2024;
- Email correspondence with Mr. Chris Buckreus, PE, SE (Schaefer) from September 23, 2024.

- Existing conditions Exhibit (Sheet C100 and C101) prepared by LJB dated October 30, 2023.

- Site Plan Exhibit (Sheet C300 and C301) prepared by LJB dated October 30, 2023.

Based on a review of Schaefer's document dated September 23, 2024, the following information is summarized:

- Maximum column and wall load for Bus Wash (slab-on-grade, one story building over footprint of approximately 62 feet by 34 feet) and Fueling Station (canopy and roof structure) are 60 kips and 2.65 kips per lineal feet (klf) respectively.

- The dimensions of GDRTA Paratransit Bus Garage (Garage) are approximately 208'-6" along north-south orientation, and the dimensions along the east-west orientation range from approximately 291 feet along the northern perimeter to 345 feet along the southern perimeter. The wall along the western perimeter is inclined at an angle of 75.6º to horizontal. The Garage is slab-on-grade addition (no basement) at finished floor elevation near El. 739 feet. The maximum interior column load is 235 kips and that for exterior (perimeter) column load is 120 kips under service case. The proposed bus garage building will provide 75 spaces for parking vehicles.

- The Garage building columns are planned to be supported by group of auger-cast piles with grade beam spanning between the columns. However, the aggregate pier foundation option (presented below) is also being considered for cost-comparison purposes.

- The roof framing plan of GDRTA Garage Building indicates presence of truss structures.

- Floor slab loads on the GDRTA Building and fuel station are in the range of 250 pounds per square foot (psf), and that on the bus wash is around 100 psf.

A grading plan has not been yet prepared at the time of this report addendum, but the grading is expected to be relatively minimal based on our understanding of the project, finished floor elevation of building(s), and the existing grades.

Based on LJB Plan Sheet C301, the proposed construction also involves a new parking lot, and a heavy-duty lane dedicated for fuel truck loop to the east side of the existing building at 601 Longworth Street. Additional borings, as part of supplemental study, will be required to provide design recommendations for pavement subgrade over that area.

2.0 DEMOLITION CONSIDERATIONS

As mentioned above, the project includes the complete demolition of the existing Building 705. The building demolition should include the complete removal of below-grade foundations and floor slabs. At this time, a foundation plan for the existing building has not been made available for

review as part of the preparation of this addendum. If foundation plans and construction record for the existing building do not exist, we recommend that additional exploration (test pit or geophysical testing) be performed after the removal of superstructure to explore the type, size, and bearing depth of existing foundation. If the building demolition encounters deep foundations beneath the existing building, we should be contacted to provide recommendations for dealing with these obstructions. The pavement layers on parking/driveway areas should also be completely removed.

The LJB Plan showing existing conditions (Sheet C100 dated October 30, 2023) indicates the presence of several utilities that include underground electric, storm sewers, etc. running across the proposed construction area. All existing utilities within the footprint of the proposed building(s) footprint should be removed or relocated at least 5 feet beyond the perimeter of the proposed structure(s). The resulting excavations from the removal of utilities should be backfilled with structural fill, placed and compacted in accordance with the recommendations provided in our July 2021 Geotechnical Report. Alternatively, the utility excavations can be backfilled with controlled low-strength mortar or flowable fill.

Stripped asphalt, concrete pavement, construction rubbles and demolition debris are not suitable for reuse as structural fill. The proposed construction area for the new building and pavement subgrade should be thoroughly cleaned of any demolition debris or concrete remnants or any other deleterious materials before placing any new structural fill to bring the site to desired subgrade elevation.

We strongly recommend performing a pre-demolition and pre-construction survey of existing structures within 200 feet of the proposed building which could potentially be impacted during excavation/demolition and construction activities. Please note that the existing brick-façade building to the east side of the proposed garage building is less than 100 feet away from the proposed construction. Periodic monitoring of the existing structures should be performed during excavation and construction of the new structures. UES can assist with preconstruction surveys and periodic monitoring as part of additional scope.

Also, existing storm sewers run on the north and south sides of the proposed building at 705 Longworth Street. The existing storm sewers are about 15 to 17 feet below the existing ground. A camera inspection for existing sewer is recommended during pre-construction and post-construction survey for the documentation of existing conditions.

All exposed subgrades in the construction area should be proof rolled after performing required undercut and prior to placing any fill. Please refer to **Site Preparation and Earthwork Recommendations** for further information on proof-rolling and earthwork considerations.

3.0 AGGREGATE PIERS

With removal of the existing building and size of the proposed structure, it is our opinion that aggregate piers would also provide a suitable option to support the structure. The subsurface

conditions generally consist of existing undocumented/uncontrolled fill and marginally competent alluvium in the upper 19.5 feet of boring. The upper 19.5 feet of soil were deemed to be unsuitable for direct support of foundations and floor slabs and hence recommended to be penetrated by foundation systems (auger-cast piles or helical piles) in our July 2021-Geotechnical Report. We recommend that shallow foundations and the slab supported over an aggregate pier system be considered for value engineering purposes.

Vibration during the installation of aggregate piers could be a concern for surrounding structures and existing utilities in the vicinity. We recommend a pre-construction survey and periodic monitoring of adjacent structures be performed as discussed above. Any concerns by the aggregate pier contractor related to vibrational disturbance/damage (such as to the storm sewer pipes) should be accounted for in the overall design layout. Alternative ground improvement methods in the vicinity of concern may be necessary.

Aggregate piers are a ground improvement technique that strengthens and stiffens the subsurface soils to support higher footing and floor slab bearing pressures that can be installed by either vertical compaction (Rammed Aggregate Piers) or vibration (Vibratory Piers). The rammed aggregate piers are typically constructed by first auguring 24- to 36-inch-diameter holes to pre-determined depths (typically in the range of 10 to 25 feet below grade) below the proposed foundation bearing elevations, and then by backfilling the holes with aggregate compacted in thin lifts. Compaction is achieved using high-frequency impact hammers that deliver a vertical ramming energy that densifies the aggregate and forces it laterally into the sidewalls of the hole. This action increases the lateral stress in the surrounding soil, thereby further stiffening the stabilized composite soil mass to increase the bearing capacity. For vibratory piers, a hollow mandrel, charged with crushed stone and the mandrel is vibrated into the ground and the stone is placed at the design depth in subsequent layers to create a similar lateral improvement as described above.

Aggregate pier construction may reduce time for foundation placement as compared to other deep foundation systems since conventional spread footings are placed directly on the reinforced soil mass, and there is no set up time for the aggregate pier elements.

The design and construction of this ground improvement technique is typically proprietary and should be performed by a qualified Design/Build Contractor using the subsurface information included in this report. Schaefer requested Geopier's local representative to review the subsurface conditions for the project and based upon their initial comments, an allowable bearing pressure of 5,000 psf should be able to be achieved using the aggregate piers; however, complete analysis and design should be performed by the ground improvement contractor. We recommend that aggregate piers for foundations penetrate the existing undocumented/uncontrolled fill and weak (soft to medium stiff) alluvium.

For this ground improvement system, we recommend that the following issues be considered during design prior to construction.

a. Specifications for aggregate pier foundation systems should be prepared by a qualified Design/Build Aggregate Pier Contractor (Aggregate Pier Contractor), including the layout and spacing of the aggregate piers.

b. The Aggregate Pier Contractor should coordinate with the Structural Engineer on the tolerable settlements of the proposed structure and design the aggregate piers to accommodate those tolerable settlements.

c. The selection of the aggregate pier installation method should be determined by the Aggregate Pier Contractor. The Aggregate Pier Contractor should have a plan if unanticipated encumbrances (e.g., boulders, cobbles, construction rubbles, demolition debris, etc.) are encountered that result in premature installation depths of the aggregate piers. If the Aggregate Pier Contractor indicates that complete removal of such obstacles is not required for their installation, we recommend that this material be removed within at least 3 feet of the floor slab subgrade.

d. The site plan should be reviewed for potential conflicts with the aggregate pier locations and the location of existing and proposed utilities, with respect to the influence zone of the reinforced soil.

e. The aggregate pier installations should be conducted under the observation of the Project Geotechnical Engineer, or representative thereof, to verify proper installation procedures and document observed changes in the explored soil conditions.

* * * *

We appreciate the opportunity to be of continuing service on this project. If you have any questions concerning the information contained herein, please do not hesitate to contact us.

Respectfully submitted,
GEOTECHNOLOGY LLC (DBA UES)

Suraj Khadka, PE
Project Manager

Joseph S. Burkhardt, PE
Geotechnical Department Manager

SK/JB:sk/jb

Copies submitted: Mr. David Henners, AIA, RIBA (Champlin Architecture)-email
Mr. Chris Buckreus, PE, SE (Schaefer)-email

Construction Terms and Conditions

The following Terms and Conditions are hereby incorporated into and made a part of the Contract, except as they may be modified by the terms of the Contract, or any Special Conditions included herein.

1. Bid Guaranty

Bonds are required for all construction or facility improvement contracts and subcontracts. Pursuant to Section 153.54 et seq. of the Ohio Revised Code, bidders shall submit a bid guaranty in the form of either:

1) A bond for the full amount of the bid conditioned that if the bid is accepted, the bidder after the awarding or the recommendation for awarding the contract, will enter a proper contract based upon the bid; or

2) A certified check, cashier's check, or letter of credit pursuant to Chapter 1305, Ohio Revised Code, in the amount of ten percent of the base bid amount. If a ten percent guaranty is submitted, provided that the bid is accepted, the bidder will, after the awarding or recommendation for awarding the contract, enter a proper contract and indemnify the RTA against all damages suffered by failure to perform the contract by supplying a performance bond in accordance with Section 153.54(2) et. seq. of the Ohio Revised Code for the full amount of the contract.

2. Performance Bond

The successful bidder shall furnish, at its own expense, a performance bond for 100 percent of the contract price no more than (5) days after notification of award, as a guarantee of good faith on behalf of the contractor that the terms of the specifications will be complied with. The performance bond shall, on its face, reference the date(s) of the contract period and the material, equipment or service covered by the contract. This bond shall be guaranteed by a surety company licensed to do business in the State of Ohio. The performance bond shall be conditioned on the complete performance of the contract, in accordance with the Ohio Revised Code Section 306.43. The RTA will not agree to release the surety on a performance bond until at least sixty (60) days after the acceptance of the project, to be provided under the contract, and the RTA reserves the right to require the surety to remain bound thereafter to the extent that the RTA may reasonably deem it necessary to do so to protect itself from the possibility of defective goods and/or services.

3. Release of Liens

The lien laws of the State of Ohio shall govern all work and materials. The Contractor shall furnish the Owner with each estimate for payment and before final payment is made, a full Release of Lien signed by all Subcontractors and Materialmen associated in any way with the work. If any Subcontractor refuses to furnish a release or receipt in full, the Contractor may furnish a bond satisfactory to Owner to indemnify the Owner against any lien. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all the monies that the later may have been compelled to pay in discharging such lien, including all costs and a reasonable Attorney's fee.

4. General Safety Rules

Violation of, or noncompliance with, of any of these work safety rules and/or any other safety work rules may be cause for immediate termination of any contractor.

1) Accidents or injuries shall be reported to the supervisor for immediate attention.

2) Hard hats shall be always worn while on the construction site.

3) Excavations and trenches:

a) Inspection of the excavation or trench, adjacent areas, and protective systems must be made by a competent person daily or as required by changing conditions before employees are permitted to enter the excavation or trench.

b) No employee is to enter a trench that is five feet or more in-depth unless it is in stable rock or is protected by one of the following means: sloped (laid back), shored, sheeted, boxed, or by an engineered system designed to prevent a cave-in.

c) Covered, secured and clearly marked as “floor opening”, or

d) An access/egress ladder will be placed in all trenches 4 or more feet in depth and shall not be more than 25 feet from those employees working in the trench.

4) Fall protection is required when:
   a) The walking-on or working surface is six (6) feet or more above the next lower level.
   b) Working above any hazardous equipment or machinery regardless of height.
5) Floor openings shall be protected by a standard guardrail system.
6) Confined space entry is prohibited without the permission of your supervisor.
7) Tools shall be operated by authorized personnel, with guards furnished by the manufacturer in place.
   a) Electric powered tools: shall be plugged into a circuit that is positively grounded or is protected by a ground fault circuit interrupter. Tools and cords are to be inspected for damage prior to use.
   b) Hand tools: shall not be used for any other purpose than that intended, and all damaged and worn parts are to be promptly repaired and/or replaced.
   c) Power actuated tools: shall be used by qualified personnel who have been instructed and trained in their safe use.
8) Good housekeeping shall be practiced on all projects. Walkways, stairways and ladder accesses shall be kept clear of debris and rubbish.
9) Nails shall be turned down or removed from lumber.
10) Safety glasses, goggles or face shields shall be worn on grinding, chipping, welding, or other operations where eye injuries may result.
11) Hearing protection shall be worn when exposed to noise hazards.
12) Shoes shall be first grade, hard soles, and ankle high.
13) Gloves shall be worn by those handling debris, old lumber, and rough or sharp-edged material.
14) Clothing shall be appropriate to the duties being performed. Cuffed trousers, torn or loose clothing is not recommended. Shorts or cutoffs, tennis shoes and working without a shirt are prohibited.
15) Access ladders shall have side rails extending three feet above the landing area and shall be securely fastened. The ladder feet shall be placed on a substantial base. The area around the top and bottom of the ladder shall be kept clear of debris and materials.
16) Taglines shall be used when raising or hoisting material or equipment.
17) Fighting, horseplay or practical jokes shall not be permitted on the job.
18) Intoxicating beverages and drug possession or use, before or during working hours are strictly forbidden.
19) Compressed gas cylinders must be stored upright, secured, capped and separated.
20) Hazardous materials: information on specific hazardous materials used on this project is available upon request. Material safety data sheets shall be in the job site offices or a designated location.
21) Asbestos removal is forbidden. If asbestos is encountered or is suspected, notify your supervisor immediately.

22) Hoisting personnel on heavy equipment by unapproved methods is prohibited. Riding on a crane hook/ball or on a load will result in the dismissal of the rider and the operator.

23) Report any violations of the safety rules to your immediate supervisor for correction, including any hazards not specifically listed herein.

24) All posted safety rules shall be obeyed and shall not be removed except by management's authorization.

5. Contractor's Superintendent

The Contractor shall keep the same competent superintendent and any necessary assistants on the work during its progress. All shall be satisfactory to the Project Manager.

Superintendent shall have previous experience in this type of work and shall maintain progress schedule and be authorized to make field decisions in the absence of the Contractor. They shall not be required to perform work not related to administering, expediting or coordinating the work under this Contract.

The Contractor shall attend to every part of the work personally, or through his competent foremen, who shall be constantly on the work, lay it out and give all necessary lines, levels, patterns and dimensions according to the accompanying drawings and these Specifications, and shall verify that Drawings and Specifications are observed by all subcontractors and employees.

They shall inspect all materials when delivered and see that they are properly stored and protected from damage until used and must keep himself familiar with the working drawings, scale and full-size details and Specifications concerning all parts of the work and must report to the Project Manager for correction of apparent errors, either in the drawings or Specifications, as soon as discovered.

The Contractor shall provide a Project Manager during the entire duration of the delivery, installation and field testing of the above-named project.

The Contractor shall comply in every respect with the latest edition of the Ohio Building Code and the Code's subsequent approved amendments. The Contractor shall be solely responsible for any damage, injury or delay caused to the Owner, or others, through any failure or negligence to observe said laws or regulations. The Contractor shall also give all required notices to the proper authorities (including those for traffic obstruction), obtain all official inspections, permits, and licenses made necessary by the work and shall comply with all laws, ordinances, rules, and regulations pertaining thereto.

6. Certified Payrolls and Wage Determination

The Contractor shall provide RTA with contractor and subcontractor certified copies of each weekly payroll within seven (7) days after the regular payroll date. Following a review by the Owner for compliance with state and federal labor laws, the payroll copy shall be retained for later review by FTA.

A contractor may use the Department of Labor Form WH 347, "Optional Payroll Form", which provides all the necessary payroll information and certifications. This Department of Labor form may be purchased at a nominal cost from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Mechanics and laborers are required to be paid on the basis of a standard 8-hour workday and a 40-hour work week. Any work more than eight (8) hours a day or 40 hours a week must be compensated at a rate of no less than 1 1/2 times the worker's base rate.

Prevailing Wages shall be paid in accordance with the Federal Wage Decision and the Ohio Department of Industrial Relations Wage Determination Schedule(s) effective during the period of the Contract and as provided for in Sections 4115.02 through 4115.16 of the Ohio Revised Code. The higher rate per classification will be used. Each Contractor must submit an affidavit that Prevailing Wages have been paid prior to receipt of final payment.

The Contractor will pay all laborers and mechanics employed on the project at least once a week and at a rate not less than the minimum wage specified in a wage determination formally issued by the Secretary

of Labor. A copy of this determination is included in this solicitation, and the award of the contract is to be conditioned upon the Contractor accepting the terms of this wage determination schedule.

The Contractor must comply with the Copeland Anti-Kickback Act, which prohibits the Contractor from inducing any persons employed on the project to give up any portion of their pay.

7. Security Measures

All contractors are required to display an identification badge supplied by RTA while on RTA premises. Badges must be worn where they can be seen. This requirement applies to every employee of all contractors and/or subcontractors. All contractors' employees are also required to wear clothing which identifies the company for which they work (i.e., uniform, hard hat, jacket, etc.). Badges must be obtained from the Project Manager and must be returned upon completion of the project. A fee will be charged for any badges that are lost or not returned and will be deducted from the final project invoice.

8. Occupancy during the Work

The building scheduled for improvements will be used during the work of this contract. However, the contractor will have the ability to cordon off and control access to his or her work areas based on safety and security requirements. The contractor shall develop its site access plan and present it to the RTA Project Manager for final approval.

9. Site Access

Access will be restricted to those areas designated by the Owner. Protection must be provided to ensure damage does not occur. If Contractor operations result in any damage, damages shall be repaired within 24 hours at no additional cost to the RTA. Limited parking will be made available for the contractor's employees.

10. Project Signs

No project signs will be allowed on the project other than a project sign provided by the Owner.

11. Differing Site Conditions

The contractor shall promptly, and before the conditions are disturbed, give a written notice to the project manager of (1) subsurface or latent physical conditions at the site which differ materially from those indicated in this contract, or (2) unknown physical conditions at the site, of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract.

The project manager shall investigate the site conditions promptly after receiving notice. If the conditions do materially differ and cause an increase or decrease in the contractor's cost of, or the time required for, performing any part of the work under this contract, whether changed as a result of the conditions, an equitable adjustment shall be made under this clause and the contract modified in writing accordingly.

No request by the contractor for an equitable adjustment to the contract under this clause shall be allowed, unless the contractor has given written notice required; provided that the time prescribed in (a) above for giving written notice may be extended by the owner.

No request by the contractor for an equitable adjustment to the contract for differing site conditions shall be allowed if made after final payment under this contract.

12. Site Investigation and Conditions Affecting the Work

The contractor acknowledges that it has taken steps reasonably necessary to ascertain the nature and location of the work, and that it has investigated and satisfied itself as to the general and local conditions which can affect the work or its costs, including but not limited to (1) conditions bearing upon transportation, disposal handling, and storage of materials; (2) the availability of labor, water, electric power and roads; (3) uncertainties of weather, river stages, tides, or similar physical conditions at the site; (4) the conformation and conditions of the grounds; and (5) the character of equipment and facilities

needed preliminary to and during work performance. The contractor also acknowledges that it has satisfied itself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the RTA, as well as from the drawings and specifications made a part of this contract. Any failure of the contractor to take the actions described and acknowledged in this paragraph will not relieve the contractor from responsibility for estimating properly the difficulty and cost of successfully performing the work, or for proceeding to successfully perform the work without additional expense to the RTA.

The RTA assumes no responsibility for any conclusions or interpretations made by the contractor based on the information made available by the RTA. Nor does the RTA assume responsibility for any understanding reached or representation made concerning conditions, which can affect the work by any of its officers or agents before the execution of the contract unless the understanding or representation is expressly stated in the contract.

If the Contract Document, law, ordinances, rules, regulations, or directives of the RTA or any public authority having jurisdiction require any work to be specifically inspected, tested or approved by someone other than the Contractor, the Contractor will give RTA timely notice of readiness thereof. The Contractor will furnish the RTA the required certificates of inspection, testing, or approval.

The cost of all such inspections, tests, and approvals shall be borne by the Contractor unless otherwise provided. Neither observation by the RTA, nor inspections, tests or approvals by persons other than the Contractor shall relieve the Contractor from obligations to perform the work in accordance with the requirements of the Contract Documents.

13. Other Contracts

The RTA may undertake and award other contracts for additional work at or near the site of the work under this contract. The Contractor shall fully cooperate with the other contractors and with RTA employees and shall carefully adapt scheduling and performing the work under this contract to accommodate the additional work, heeding any directions that may be provided by the Project Manager. The Contractor shall not commit or permit any act that will interfere with the performance of work by any other Contractor or by RTA employees.

14. Protection of Existing Vegetation, Work, and Property

The Contractor shall preserve and protect all structures, equipment, and vegetation (such as trees, shrubs, and grass) on or adjacent to the worksite, which was not to be removed and which do not unreasonably interfere with the work required under the contract. The Contractor shall only remove trees when specifically authorized to do so and shall avoid damaging vegetation that will remain in place. If any limbs or branches of trees are broken during contract performance, or by the careless operation of equipment, or by workmen, the contractor shall trim those limbs or branches with a clean-cut and paint the cut with a tree-pruning compound as directed by the project manager.

The Contractor shall protect from damage all existing improvements and utilities (1) at or near the worksite, and (2) on adjacent property of a third party, the locations of which are made known to or should be known by the contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of the contract or failure to exercise reasonable care in performing the work. If the contractor fails or refuses to repair the damage promptly, the owner may have the necessary work performed and charge the cost to the contractor. The Contractor shall determine the presence of underground utilities by utilizing the Ohio Utilities Protection Service 1 800 362 2764 at least 48 hours prior to excavation.

To ensure the protection of all public and private property from injury or loss arising from the connection with the contract, comply with the following:

1) Protect all work materials and equipment to be incorporated in this Contract whether in transit or in the storage on or off the site and under the care, custody or control of the Contractor.

2) Protect all partially installed and completed work associated with this Contract.

3) Furnish all temporary work required to complete this Contract. This will include all temporary work required to keep in operation all requisite guards, sidewalks, fences and other safeguards for the protection of the work and safety of the premises and the public.

4) Provide all temporary heat required for the prevention of damage to work and materials by freezing, as found necessary to carry on construction operations.

5) Protect other property at the site or adjacent thereto not designated for removal or replacement during construction.

6) Protect all public and private property and all persons who may be affected directly or indirectly by work performed under this Contract.

7) Promptly remedy all damage or loss (other than damage or loss covered by the "Insurance Requirements") to original condition at no additional cost to the RTA.

15. Operations and Storage Areas

The Contractor shall confine all operations (including storage of materials) on RTA premises to areas authorized or approved by the Owner. The Contractor shall hold and save the RTA, its officers, and agents, free and harmless from liability of any nature occasioned by the contractor's performance.

Temporary buildings (e.g., storage sheds, shop, offices) and utilities may be erected by the contractor only with the approval of the Project Manager and shall be built with labor and materials furnished by the contractor without expense to the RTA. The temporary buildings and utilities shall remain the property of the Contractor and shall be removed by the Contractor at its expense upon completion of the work. With the written consent of the Project Manager, the buildings and utilities may be abandoned and need not be removed.

The contractor shall, under regulations prescribed by the project manager, use only established roadways, or use temporary roadways constructed by the contractor when and as authorized by the Project Manager. When materials are transported in performing the work, vehicles shall not be loaded beyond the loading capacity recommended by the manufacturer of the vehicle or prescribed by any federal, state or local law or regulation. When it is necessary to cross curbs or sidewalks, the contractor shall protect them from damage. The Contractor shall repair or pay for the repair of any damaged curbs, sidewalks or roads.

16. Accident Prevention

The Contractor shall provide and maintain work environments and procedures which will (1) safeguard the public and RTA personnel, property, materials, supplies, and equipment exposed to contractor operations and activities; (2) avoid interruptions of RTA operations and delays in project completion dates; and (3) control costs in the performance of this contract.

For these purposes of contracts for construction or dismantling, demolition, or removal of improvements, the Contractor shall:

1) Provide appropriate safety barricades, signs, and signal lights;

2) Comply with the standards issued by the Secretary of Labor at 29 CFR Part 1926 and 29 CFR Part 1910; and

3) Ensure that any additional measures the Project Manager determines to be reasonably necessary for the purposes are taken.

If this contract is for construction or dismantling, demolition or removal of improvements with any Department of Transportation agency or component, the Contractor shall comply with all pertinent provisions of the latest version of U.S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1, in effect on the date of the solicitation.

Whenever the Owner or its representatives become aware of any noncompliance with these requirements or any condition which poses a serious or imminent danger to the health or safety of the public or RTA personnel, the project manager shall notify the contractor orally, with written confirmation, and request immediate initiation of corrective action. This notice, when delivered to the Contractor or the Contractor's representative at the worksite, shall be deemed sufficient notice of noncompliance and that corrective action is required. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to promptly take corrective action, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall not be entitled to any equitable adjustment of the contract price or extension of the performance schedule on any stop-work order issued under this clause.

The Contractor shall insert this clause, including this paragraph with appropriate changes in the designation of parties, in subcontracts.

Alternate I: If the contract will involve (a) work of a long duration with hazardous nature, or (b) performance on a government facility that on the advice of the technical representatives involves hazardous materials or operations that might endanger the safety of the public and/or RTA personnel or property, add the following paragraph (f) to the basic clause:

Before commencing the work, the contractor shall:

1) Submit a written proposal plan for implementing this clause. The plan shall include an analysis of the significant hazards to life, limb, and property inherent in contract work performance and a plan for controlling these hazards; and

2) Meet with representatives of the RTA to discuss and develop a mutual understanding relative to the administration of the overall safety program.

17. Availability and Use of Utility Services

The RTA shall make all reasonably required amounts of utilities available to the Contractor from existing outlets and supplies, as specified in the contract. The Contractor shall carefully conserve any utilities furnished.

The Contractor, at its expense and in a workmanship manner satisfactory to the Project Manager, shall install and maintain all necessary temporary connections and distribution lines. Before final acceptance of the work by the RTA, the contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia.

18. Schedules for Construction Contracts

The Contractor shall, within five (5) days after the work commences on the contract or another period of time determined by the Project Manager, prepare and submit to the Project Manager for approval three copies of a practicable schedule and show the order in which the Contractor proposes to perform the work, and the dates on which the Contractor contemplates starting and completing several salient features of the work (including acquiring materials, plant, and equipment). The schedule shall be in the form of a progress chart of suitable scale to indicate appropriately the percentage of work scheduled within the time prescribed. The Owner may withhold approval of progress payments until the contractor submits the required schedule.

The Contractor shall enter the actual progress on the chart as directed by the Project Manager, and upon doing so shall immediately deliver three copies of the annotated schedule to the Project Manager. If in the opinion of the Project Manager, the Contractor falls behind the approved schedule, the Contractor shall take steps necessary to improve its progress, including those that may be required by the Project Manager, without additional cost to the RTA. In this circumstance, the Owner may require the Contractor to increase the number of shifts, overtime operations, days of work, and/or the amount of construction plant, and to submit for approval any supplementary schedule or schedules in chart form as the Project Manager deems necessary to demonstrate how the approved rate of progress will be regained.

Failure of the Contractor to comply with requirements of the Owner under this clause shall be grounds for a determination by the Owner that the Contractor is not prosecuting the work with sufficient diligence to ensure completion within the time specified in the contract. Upon making this determination, the Owner may terminate the Contractor's right to proceed with the work, or any separable part of it, in accordance with the default terms of this contract.

19. Layout of Work

The Contractor shall lay out its work from RTA established baselines and benchmarks indicated on the drawings and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at its own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to layout any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Project Manager. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Project Manager until authorized to remove them. If such marks are destroyed by the Contractor through its negligence before their removal is authorized, the Project Manager may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.

20. Organization and Direction of the Work

When the contract is executed, the Contractor shall submit to the Project Manager a chart showing the general executive and administrative organization, the personnel to be employed in connection with the work under the contract, and their respective duties. The Contractor shall keep the data furnished current by supplementing it as additional information becomes available.

Work performance under the contract shall be under the full-time direction of (1) the Contractor, if the Contractor is an individual; (2) one or more principal partners, if the Contractor is a partnership; or (3) one or more senior officers, if the Contractor is a corporation, association, or similar legal entity. However, if the Project Manager approves, the Contractor may be represented in the direction of the work by a specific person or persons holding positions other than those identified in this paragraph.

21. Specifications and Drawings for Construction

The Contractor shall keep on the worksite a copy of the drawings and specifications and shall at all times give the owner and its representative's access thereto. Anything mentioned in the specifications and not shown on the drawings or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawings and specifications, the specifications shall govern. In case of discrepancy in the figures, in the drawings, or in the specifications, the matter shall be promptly submitted to the project manager, who shall promptly make a determination in writing. Any adjustment by the Contractor without such a determination shall be at its own risk and expense. The Project Manager shall furnish from time to time such detailed drawings and other information as considered necessary unless other provided.

Wherever in the specifications or upon the drawings the words "directed, required, ordered, designated, prescribed", or words of like import are used, it shall be understood that the direction, requirement, order, designation, or prescription, of the owner, is intended; and similarly the words "approved, acceptable, satisfactory", or words of like import shall mean approved by, or acceptable to, or satisfactory to the owner, unless otherwise expressly stated.

When "as shown, as indicated, as detailed", or words like import are used, it shall be understood that the reference is made to the drawings accompanying the contract unless stated otherwise. The word "provides", as used herein, shall be understood to mean provide completed in place that is, furnished and installed.

Shop drawings means drawings, submitted to the Project Manager by the Contractor, subcontractor, or any lower-tier subcontractor pursuant to a construction contract, showing in detail (1) the proposed fabrication and assembly of structural elements, and (2) the installation (i.e., fit, and attachment details) of materials or equipment. It includes drawings, diagrams, layouts, schematics, descriptive literature,

illustrations, schedules, performance and test data, and similar materials furnished by the Contractor to explain in detail specific portions of the work required by the contract. The RTA may duplicate, use, and disclose in any manner and for any purpose shop drawings delivered under the contract.

If the contract requires shop drawings, the Contractor shall coordinate all such drawings, and review them for accuracy, completeness, and compliance with contract requirements and shall indicate its approval thereon as evidence of such coordination and review. Shop drawings submitted to the Project Manager without evidence of the Contractor's approval may be returned for resubmission. The Project Manager will indicate approval or disapproval of the shop drawings, and if not approved as submitted, shall indicate reasons therefor. Any work done before such approval shall be at the contractor's risk. Approval by the Project Manager shall not relieve the contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for complying with the requirements of the contract, except with respect to variations described and approved in accordance with (f) below.

If shop drawings show variations from the contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at the time of submission. If the project manager approves any such variations, the RTA shall issue an appropriate contract modification, except that, if the variation is minor or does not involve a change in price or in time of performance, a modification need not be issued.

The Contractor shall submit a minimum of four (4) "owner's copies" for each shop drawing and submittal. The owner will retain one (1) copy during construction for Owner's purposes. Upon completion of the job, the Contractor shall provide the Owner with three (3) original copies. Any additional copies required by the Contractor shall also be provided. The owner will review each submittal, mark as appropriate to indicate the action taken, and return copies less one (1) retained. As an example, if the Contractor needs three (3) copies of a submittal (one for the vendor, one for a subcontractor and one for the Contractor), the Contractor shall provide a minimum of seven (7) copies (three for the Contractor's purposes, three for the Contractor to submit with three copies of operation and maintenance manuals upon completion of the job, and one copy for the owner to utilize during construction.

Upon completing the work under the contract, the Contractor shall furnish three (3) complete sets of all shop drawings as finally approved, to be included in the operation and maintenance manuals. These drawings shall show all changes and revisions made up to the time the project is completed and accepted by the RTA.

22. Shop Drawings and Planning Progression

Submit for approval, prior to preparation of shop drawings, a list of proposed submittals and a tentative schedule of all proposed shop drawings, brochures, and samples called for under the Contract.

Prepare shop drawings that establish the actual details of the work; indicate proper relation to adjoining work; amplify design details of all general, structural, architectural, mechanical and electrical equipment in proper relation to verified physical spaces; and incorporate minor changes of design or construction to suit actual conditions. Fully describe all materials and equipment to be incorporated into the project, including manufacturer's specifications and special detailed information.

The Project Manager will review shop drawings, brochures, and samples submitted in accordance with an approved shop drawing submittal schedule and return to the Contractor in a timely manner.

The Project Manager's review of shop drawings, brochures or samples is for general design information only and is not a complete check of the method of assembly, erection, or construction. The review shall in no way be construed as:

1) Permitting any departure from the contract documents, except where the Contractor, in accordance with the provisions of the General Conditions, has previously notified the RTA of such departure.

2) Relieving the contractual responsibility for any error in quality of materials, details, and omissions or otherwise, that may exist.

3) Relieving the contractual responsibility for adequate field connections, erection techniques, bracing or deficiencies in strength.

4) Relieving the full contractual responsibility for the satisfactory performance of all work and coordination of work.

5) Permitting departure from additional details or instructions previously furnished by RTA.

If the Owner decides to conduct a pre-construction conference, the successful Contractors will be notified and will be required to attend. The Project Manager's notification will include specific details regarding the date, time, and location of the conference, any need for attendance by subcontractors, and information regarding the items to be discussed.

23. Material and Workmanship (based on APR 1984)

All equipment, material, and articles incorporated into the work covered by this contract shall be new and of the most suitable grade for the purpose intended, unless otherwise specifically provided in this contract. References in the specifications to equipment, material, articles, or patented processes by trade name, make, or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material, article, or process that, in the judgment of the Contracting Officer, is equal to that named in the specifications, unless otherwise specifically provided in this contract.

The Contractor shall obtain the Contracting Officer's approval of the machinery and mechanical and other equipment to be incorporated into the work. When requesting approval, the Contractor shall furnish to the contracting officer the name of the manufacturer, the model number, and other information concerning the performance, capacity, nature, and rating of the machinery, mechanical and other equipment. When required by this contract or by the Contracting Officer, the Contractor shall also obtain the Contracting Officer's approval of the material or articles that the Contractor contemplates incorporating into the work. When requesting approval, the Contractor shall provide full information concerning the material or articles. When directed to do so, the Contractor shall submit samples for approval at the contractor's expense, with all shipping charges prepaid. machinery, equipment, material, and articles that do not have the required approval shall be installed or used at the risk of subsequent rejection.

All work under this contract shall be performed in a skillful and workmanlike manner. The Contracting Officer may require, in writing, that the Contractor remove from the work any employee the Contracting Officer deems incompetent, careless, or otherwise objectionable (R 7-602.9 1964 Jun).

24. Superintendence by the Contractor (based on APR 1984)

At all times during the performance of this contract and until the work is completed and accepted, the Contractor shall directly superintend the work or assign and have on the work site a competent superintendent who is satisfactory to the Contracting Officer and has authority to act for the Contractor. Each prime contractor shall provide superintendence for work covered by the respective prime contract and coordinate his work with the other Prime Contractors and the Construction Manager. The Construction Manager shall also provide superintendence over all other contracts.

25. Permits and Responsibilities (based on NOV 1991)

The Contractor shall, without additional expense to the Greater Dayton Regional Transit Authority, be responsible for obtaining any necessary licenses and permits, and for complying with any federal, state, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damage to persons or property that occur because of the Contractor's fault or negligence. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.

26. Use and Possession Prior to Completion

The Greater Dayton Regional Transit Authority shall have the right to take possession of or use any completed or partially completed part of the work. Before taking possession of or using any work, the administrative team shall furnish the Contractor a list of items of work remaining to be performed or corrected on those portions of the work that the Greater Dayton Regional Transit Authority intends to take possession of or use. However, failure of the Contracting Officer to list any item of work shall not relieve the Contractor of responsibility for complying with the terms of the contract. The Greater Dayton Regional Transit Authority's possession or use shall not be deemed an acceptance of any work under the contract.

While the Greater Dayton Regional Transit Authority has such possession or use, the Contractor shall be relieved of the responsibility for the loss of or damage to the work resulting from the Greater Dayton Regional Transit Authority's possession or use, notwithstanding the terms of the clause in this contract entitled "permits and responsibilities". If prior possession or use by the Greater Dayton Regional Transit Authority delays the progress of the work or causes additional expense to the Contractor, an equitable adjustment shall be made in the contract price or the time of completion, and the contract shall be modified in writing accordingly.

27. Cleaning Up (based on APR 1984)

The Contractor shall always keep the work area, including storage areas, free from accumulations of waste materials. Before completing the work, the Contractor shall remove from the work premises any rubbish, tools, scaffolding, equipment, and materials that are not the property of the Greater Dayton Regional Transit Authority. Upon completing the work, the Contractor shall leave the work area in a clean, neat, and orderly condition satisfactory to the Contracting Officer. Clean up is the specific responsibility of each separate contractor. The Construction Manager will ensure all contractors have adequately performed cleanup tasks. Cleanup shall take place daily.

28. Disputes Concerning Labor Standards

Disputes arising out of the labor standard provisions of this Contract shall not be subject to the general disputes clause of the contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

29. Certification of Eligibility

By entering into this agreement or a third-party contract financed under this agreement, the Contractor certifies that neither it (nor he nor she) nor any person or firm that has an interest in the Contractor's firm is a person or firm ineligible to be awarded government contracts by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

No part of this Contract shall be subcontracted to any person or firm ineligible for award of a government contract by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR Section 5.12(a)(1).

The penalty for making false statements as prescribed in the U.S. Criminal Code, 18 USC Section 1001.

30. Environmental, Resource Conservation, and Energy Requirements

Environmental Protection: The Contractor agrees to comply with applicable requirements of the National Environmental Policy Act of 1969, as amended, 42 USC Section 4321 et seq.; Section 14 of the Federal Transit Act, as amended, 49 USC app. Section 1610; Council on Environmental Quality Regulations, 40 CFR Part 1500 et seq.; and joint FHWA/FTA Regulations, "Environmental Impact and Related Procedures" at 23 CFR Part 771 and 49 CFR Part 622.

Air Quality: Contractor agrees to comply with applicable requirements of EPA regulations, "Conformity to State or Federal Implementation Plans of Transportation Plan, Programs, and Project Developed, Funded or Approved Under Title 23 USC or The Federal Transit Act," 40 CFR Part 51, Subpart T; and "Determining Conformity of Federal Actions to State or Federal Implementation Plans," 40 CFR Part 93. To support the requisite air quality conformity finding for the Project, the Contractor agrees to

implement each air quality mitigation and control measure incorporated in the Project. The Contractor agrees that any Project identified in an applicable State Implementation Plan (SIP) as a Transportation Control Measure, will be wholly consistent with the description of the design concept and scope of the Project set forth in the SIP.

EPA also imposes requirements pertaining to the Clean Air Act, as amended that may apply to transit operators, particularly operators of large transit bus fleets. Thus, the Contractor should be aware that the following EPA regulations, among others, may apply to this Project; "Control of Air Pollution from Motor Vehicles and Motor Vehicle Engines", 40 CFR Part 85; "Control of Air Pollution and New and In-Use Motor Vehicles and New and In-Use Motor Vehicle Engines: Certification and Test Procedures", 40 CFR Part 86; and "Fuel Economy of Motor Vehicles", 40 CFR Part 600.

Use of Public Lands: No publicly owned land from a park, recreation area, or wildlife or waterfowl refuge of national, state, or local officials having jurisdiction thereof, or any and from an historic site of national, state, or local significance may be used for the Project unless specific findings required by 49 CFR Section 303 are made by U.S. DOT.

Mitigations of Adverse Environmental Effects: Should the proposed Project cause adverse environmental effects, the Contractor agrees to take all reasonable steps to minimize such effects pursuant to 49 USC app. Section 1610, all other applicable statutes, and the procedures set forth in 23 CFR Part 771 and 49 CFR Part 622. The Contractor agrees to undertake all environmental mitigation measures that may be identified as commitments in applicable environmental documents (such as environmental assessments, environmental impact statements, memoranda of agreements, and statements required by 49 USC Section 303) and with any conditions imposed by the government as part of a finding of no significant impact or a record of this Agreement by reference. As soon as the government and the Contractor reach agreement on any mitigation measures that have been deferred, those measures will then be incorporated into this Agreement. Such mitigation measures may not be modified or withdrawn without the express written approval of the government.

31. Execution of Contract

The successful bidder must, within ten (10) days after the date of notification of the award and before the signing of the contract, furnish the following:

1) Performance Bond.
2) Labor and Materialmen Bond with a surety in the amount equal to 100% of the total contract amount.
3) Certificates of insurance and compliance from the Industrial Commission and Bureau of Workers' Compensation

Within ten (10) days after the execution of the contract, the Contractor shall furnish the following:

1) List of materials the bid is based upon and supplier.
2) An itemized Schedule of Values including labor, materials, and equipment, for all items in the bid.
3) Name of foreman or superintendent.
4) List of 24-hour emergency telephone numbers(s).

32. Builders Risk Insurance

Contractor shall provide builders risk insurance coverage covering both the interests of the Owner, Contractor and all applicable subcontractors in accordance with the following:

1) Said policy of insurance to be written utilizing either a) the 1995 ISO Builders Risk Coverage form CPOO 20 with special causes of loss, form CP 20 30 11 attached and endorsed to include the perils of flood, surface water, backup of sewers and drains, and earthquakes or b) an inland marine builders risk coverage form which is certified by the insurance underwriter to be no more restrictive than the iso form CP 00 20, 1995 edition.

2) The policy will carry a maximum deductible of $1,000-$5,000, depending on the size of the project. The Contractor will be financially responsible for absorbing all losses within the deductible.

3) The policy will be written on a completed value basis. The limit will be equal to 100% of the total contract award amount.

4) Valuation for all property, including but not limited to the property of others in the insured's care, custody, and control, will be the replacement cost.

5) The policy will be endorsed to cover property in transit.

6) The policy will be endorsed to cover off-site storage of building materials, contents, and supplies.

7) The policy will be endorsed to include form CP 11 21 builders' risk-theft of building materials.

8) The policy shall be endorsed to provide the owner with the right to approve/disapprove all settlements.

9) Contractor shall provide Owner with a certificate of insurance evidencing each of the above items prior to initiating any construction activity. Said certificate of insurance will include a provision providing the Owner with 30 days written notice of cancellation, material change or non-renewal. The standard "endeavor to" wording will be deleted from any certifications provided by the Contractor to the Owner.

10) It is agreed that all coverage placed by the Contractor on behalf of the Owner shall be underwritten by an insurance company licensed and admitted by the State of Ohio. Said insurance company will carry a current minimum A.M. Best rating of A-

33. Excusable Delays

Except for defaults of subcontractors at any tier, the Contractor shall not be in default because of any failure to perform this contract under its terms if the failure arises from causes beyond the control and without the fault or negligence of the Contractor. Examples of these causes are (1) acts of God or of the public enemy, (2) acts of the RTA in either its sovereign or contractual capacity, (3) fires, (4) floods, (5) epidemics, (6) quarantine restrictions, (7) strikes, (8) freight embargoes and (9) unusually severe weather. In each instance, the failure to perform must be beyond the control of and without the fault or negligence of the Contractor. "Default" includes failure to make progress in the work to endanger performance.

If the failure to perform is caused by the failure of the subcontractor at any tier to perform or make progress, and if the cause of failure was beyond the control of both the Contractor and subcontractor, and without the fault or negligence of either, the Contractor shall not be deemed to be in default, unless-

1) The subcontracted supplies or services were obtainable from other sources.
2) The RTA ordered the contractor in writing to purchase these supplies or services from the other source; and
3) The Contractor failed to comply reasonably with this contract.

Upon request of the Contractor, the RTA shall ascertain the facts and extent of the failure. If the RTA determines that any failure to perform results from one or more of the causes above, the delivery schedule shall be revised, subject to the rights of the RTA under the termination clause of the contract.

34. Warranty and Guarantee

Contractor guarantees that all equipment delivered and installed under the Contract will be made from materials suitable and adequate for the purposes intended and described in the Contract, and in a workmanlike manner in accordance with the best engineering practice, and that such equipment will fully comply with the Drawings, Specifications and Contract documents including all performance requirements and representations

All specialties, equipment, and parts supplied by the Contractor shall be the same design and model on all equipment purchased under this Specification. The Contractor shall assume all responsibility for these specialties, parts, and equipment whether manufactured by the Contractor or purchased by him/her from another source.

The contractor shall warrant and guarantee the contracted services for a period of 365 days from the date of acceptance for both labor and materials. All materials, specialties, equipment or accessories that prove defective in normal operation within the above period shall be replaced or repaired by the Contractor free of any cost to the RTA, including all material, labor, and transportation costs. Transportation of warranty replacement parts shall be by the fastest means possible, including airfreight if the part is of a size that can be reasonably shipped via airfreight.

If it becomes necessary under the terms of this guarantee that any part or material must be redesigned, replaced or repaired by this contractor, such replaced items and any other item affected by this replacement shall be guaranteed for an additional one (1) year period from the date of replacement. Any needed redesign efforts to correct defective parts will be at additional cost to RTA.

The Contractor will transfer to the RTA all commercial warranties received from subcontractors and suppliers for all Equipment, Material and Labor used to complete the project.

In the event of termination either for default or for the convenience of the RTA, the contractor shall account for any property in its possession paid for from funds received from the RTA, or property supplied to the contractor by the RTA.

General Terms and Conditions

The following General Terms and Conditions are hereby incorporated into and made a part of the Contract, except as they may be modified by the terms of the Contract or any Special Conditions included, herein.

1. General Information

The Greater Dayton Regional Transit Authority (RTA), with its administrative offices located at 4 S Main St., Dayton, OH 45402 is a regional transit authority of the State of Ohio organized and operating under Ohio Revised Code Sections 306.30 et seq. and funded in part by grants from the Federal Transit Administration (FTA) of the United States Department of Transportation.

The term “Contract” as used herein shall include a document signed by the parties, containing at a minimum the names of the parties, a general description of the work to be performed, the term of performance and the Contract price. Such document shall also identify all other documents incorporated in the Contract, including but not limited to these General Terms and Conditions.

The term “Contractor” as used herein, shall mean the firm or individual entering into a contract with RTA for the Work defined in the contract, and specifically shall include the term “Consultant.” Contractor acknowledges and agrees that it is an independent Contractor and neither it nor any of its employees shall be considered employees of RTA.

The term “Subcontractor” as used herein shall refer to a firm or individual which directly or indirectly enters a contract with the Contractor for performance of a portion of the Work defined in the Contractor’s Contract with RTA, and shall include sub-subcontractors of any tier, consultants, subconsultants, vendors, suppliers, but not the employees of the Contractor or any Subcontractors, as the context may imply.

By entering this Contract, Contractor represents and warrants that it and its Subcontractors, if any, are fully qualified to perform the Work required hereunder and possess any necessary licenses or permits and shall maintain such licenses and permits during the term of this Contract and any warranty period.

2. Payment

Unless otherwise specified herein, RTA shall pay Contractor the Contract price upon completion and acceptance of the Work hereunder, and submission and approval of an appropriate invoice. Completion of the Work shall include the provision of any documents including or relating to warranties, releases of liability, and operating and parts manuals as appropriate. Payment to Contractor will generally be made within thirty (30) calendar days following approval by RTA of such invoice. Such approval or payment shall not constitute acceptance or approval of the services and/or materials invoiced. Late payments shall accrue no interest.

Within 15 working days after receiving payment from RTA, the Contractor agrees to pay each subcontractor under this contract for satisfactory performance of its contract. The Contractor agrees further to return retainage payments to each subcontractor within 15 days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time frame may occur only for good cause following written approval of the RTA. This clause applies to both SBE, DBE and non-SBE, DBE subcontractors. When applicable, the RTA may use the following mechanisms to ensure prompt payment.

- Language providing that Contractors and subcontractors will use appropriate alternative dispute resolution mechanisms to resolve payment disputes.
- Language providing that Contractors will not be reimbursed for work performed by subcontractors until the Contractor ensures that the subcontractors are paid promptly for work, they have performed.
- Enforcement of public funds liens law and use of a similar mechanism for nonpublic improvement projects.
- Other applicable mechanisms as necessary.

RTA's terms of payment are net 30 days after the date of delivery of an order by the Contractor. Payment for products or services delivered to and accepted by RTA shall be at the contract price. RTA shall order materials using a purchase order referencing this contract, and such purchase order shall be the only authorization the contractor shall use to deliver materials and invoice the RTA. Contractors shall be paid, upon the submission of activity reports with proper invoices or vouchers, the prices stipulated herein for supplies delivered and accepted or services rendered and accepted, less deductions, if any, as herein provided, within thirty (30) days.

3. Ownership of Documents

RTA shall be the owner of all plans, scope of work and related documents prepared pursuant to this Contract or provided to Contractor by RTA. Any reuse of the plans, scope of work or related documents by RTA for other than the purpose intended by this Contract shall impose no liability on the Contractor.

4. Maintenance of Records

The Contractor shall maintain records of actual overhead costs and actual general and administrative costs in conformity with generally accepted accounting principles, and subject to Title 41 of the C.F.R. The Contractor shall maintain records of direct labor costs and other applicable payroll expenses. Labor and payroll records shall be in sufficient detail to indicate, at a minimum, employees by name, employee's time spent on the project, and an itemization of applicable fringe benefit expenses.

5. Tax-Exempt

RTA is exempt from payment of the State of Ohio sales tax and Federal excise taxes, and all pricing and invoicing under this contract shall exclude such items. Contractor shall be solely responsible for payment of all taxes or assessments accruing from its activities under this contract, including, but not by way of limitation, income taxes, payroll taxes, or other federal, state or local taxes relating to the generation of income or the employment of individuals.

6. Audit and Inspection of Records

Contractor shall permit the authorized representatives of RTA, its member entities, the Ohio Auditor of State, the U.S. Department of Transportation and the Comptroller General of the United States access to any books, documents, papers and records of the Contractor which are directly pertinent to this contract, for the purpose of making audit, examination, excerpts and transcriptions until the expiration of three (3) years after final payment under this contract.

Contractor further agrees to include in all its subcontracts hereunder, a provision to the effect that the subcontractor agrees that RTA, its member entities, the Auditor of State, the U.S. Department of Transportation and the Comptroller General of the United States or any of their duly authorized representatives shall, until the expiration of three (3) years after final payment under the subcontract, have access to books, documents, papers and records of such subcontractor involving transactions related to the subcontractor for the purpose of making audit, examination, excerpts and transcriptions. The term "subcontract" as used in this clause excludes (1) purchase orders not exceeding $10,000 and (2) subcontracts or purchase orders for public utility services at rates established for uniform applicability to the general public.

The periods of access and examination described above, for records which relate to (1) appeals under the "Disputes" clause of this contract, (2) litigation of the settlement of claims arising out of the performance of this contract, or (3) costs and expense of this contract as to which exception has been taken by the Comptroller General or any of his duly authorized representatives, shall continue until such appeals, litigation, claims or exceptions have been disposed of.

7. Insurance

The Contractor shall maintain, at its own expense, throughout the period of the Contract and any extensions thereof the following minimum insurance coverages of the types and in the amounts described below that are applicable to the scope of work being performed:

- Workers Compensation and Employer's Liability Insurance. The contractor must carry Workers' Compensation Insurance (including occupational disease) in compliance with Workers' Compensation statutes of any applicable jurisdiction in which the Work is to be performed. For the attainment of Workers Compensation in monopolistic states, including Ohio, coverage must be secured through the state fund. If the Contractor is a qualified self-insurer in compliance with the laws of the state, this is also acceptable. A certificate of compliance from the appropriate workers' compensation bureau or board must be provided with the certificate of insurance. The contractor must also carry Employer's Liability Insurance with minimum limits of $500,000 for each accident; $500,000 for disease (per employee); and $500,000 for disease. This policy must include Ohio "Stop Gap" coverage.

- Commercial General Liability Insurance. The contractor must carry Commercial General Liability Insurance written on ISO form CG 00 01 10 01 (or its equivalent) with limits of $1,000,000 per occurrence and $2,000,000 in the aggregate. The general aggregate limit shall apply separately to this project. RTA (including its directors, officers, employees, and volunteers) must be named as an additional insured on the CGL for liability arising out of the acts or omissions of the Contractor, including coverage for liability arising out of products and completed operations. The coverage afforded to RTA shall be primary to any other insurance carried by the RTA, and the RTA's coverage shall not contribute to any loss made pursuant to this coverage grant. Commercial General Liability coverage (including RTA's status as additional insured) shall be maintained for at least two years after completion of Contractor's work performed under this contract.

- Commercial Auto Liability Insurance. Contractor shall carry Commercial Automobile Liability Insurance covering all owned, leased and non-owned vehicles used in connection with the work to be performed under this contract, with limits of not less than $1,000,000 combined single limit per accident for bodily injury and property damage. RTA shall be afforded coverage under this policy for any liability arising out of the acts or omissions of Contractor.

- Excess/Umbrella Insurance. Contractor shall carry Commercial Excess or Umbrella Liability Insurance over the Commercial General Liability, Employer's Liability and Commercial Automobile Liability policies in the amount of $2,000,000 combined single limit. The Excess/Umbrella policy is subject to all requirements of the underlying policies as set forth herein.

- Builders' Risk Insurance. If the work involves construction, the Contractor shall provide and maintain, during the progress of the work and until execution of the Certificate of Contract Completion, a Builder's Risk Insurance policy to cover all work during construction including falsework, temporary buildings, scaffolding, and materials used in the construction process (including materials designated for the project but stored off-site or in transit). The coverage shall equal the total completed value of the work and shall provide recovery at replacement cost.

    - Such insurance shall be on a special cause of loss form, providing coverage on an open perils basis insuring against the direct physical loss of or damage to covered property, including but not limited to theft, vandalism, malicious mischief, earthquake, tornado, lightning, explosion, breakage of glass, collapse, water damage, and testing/startup.

    - Coverage shall include coverage for costs other than replacement of building materials including, but not limited to, the reasonable extra costs of the architect/engineer and reasonable Contractor extension or acceleration costs. This coverage shall also include the reasonable extra costs of expediting temporary and permanent repairs to, or permanent replacement of, damaged property. This shall include overtime wages and the extra cost of express or other means for rapidly transporting materials and supplies necessary for the repair or replacement.

    - The policy shall specifically permit and allow for partial occupancy by the owner prior to the execution of the final Certification of Contract Completion, and coverage shall remain in effect until all punch list items are completed.

- The Builder's Risk deductible may not exceed $5,000. The Contractor or subcontractor experiencing any loss claimed under the Builder's Risk policy shall be responsible for that loss up to the amount of the deductible.
- If the Contractor is involved solely in the installation of material and equipment and not in new building construction, the Contractor shall provide an Installation Floater policy in lieu of a Builder's Risk policy. The policy must comply with the provisions of this paragraph.

- Pollution Liability Insurance. If the Work involves environmental remediation, demolition or such other risks as the RTA reasonably determines to create a pollution hazard, Contractor shall purchase and maintain pollution liability coverage of at least $1,000,000 per occurrence. This policy shall cover property damage, bodily injury and cleanup/pollution remediation costs caused by a pollution event and otherwise excluded under Contractor's Commercial General Liability policy. RTA shall be afforded protection under this policy as an additional insured, including coverage for claims arising out of Contractor's products and completed operations.
- Aircraft/Watercraft Liability Insurance. If the Contractor is using aircraft or watercraft in performance of the Work under this contract, Contractor shall disclose this to RTA prior to contract execution. Contractor shall carry aircraft and/or watercraft liability insurance, including coverage for non-owned and hired craft, and RTA shall determine the appropriate limits which must be carried by Contractor.
- Railroad Protective Liability Insurance. If the Work is being performed within 50 feet of a railroad, Contractor shall maintain Railroad Protective Liability insurance coverage with limits of $2,000,000 per occurrence and $6,000,000 in the aggregate. Contractor shall name RTA and the affected railroad as additional insured(s) on such policy for liability arising out of Work performed under this contract.
- Fidelity Bond/Crime. If Vendor or its employees will be on the premises of RTA in connection with performance of the Work under this contract, Vendor shall carry no less than $100,000 in Third Party Crime Coverage for the benefit of the RTA in the event of theft or other intentional harm to RTA's property by Vendor's employees.

Requirements common to all policies:

- Contractor shall be solely responsible for reimbursing any deductible amount to the insurer, even if payment is being made on behalf of RTA as an additional insured on the Contractor's policy. Any deductibles or self-insured retentions in excess of $5,000 must be disclosed and approved by RTA.
- Contractor waives all rights of recovery it may otherwise have against RTA including its directors, officers, employees, and volunteers) to the extent these damages are covered by any of Contractor’s insurance policies as required in this contract.
- All insurance required hereunder shall be placed with insurers that have a minimum A.M. Best’s rating of A-/X and shall be licensed, admitted insurers authorized to do business in the state of Ohio.
- Certificate(s) of insurance showing that Contractor’s insurance coverages follow the insurance requirements set forth below must be completed by the Contractor’s insurance agent or company after the contract has been awarded. All certificates (other than Ohio workers' compensation) shall provide for thirty (30) days written notice to RTA prior to cancellation or non-renewal of any insurance referred to therein. The certificate shall reference RTA's status as an additional insured with primary/noncontributory coverage under both the General Liability and Auto policies.
- Failure of RTA to receive certificate(s) or other evidence of full compliance with these insurance requirements (or failure of RTA to identify and/or object to a deficiency in the certificate(s) that is/are provided by Contractor) shall not be construed as a waiver of Contractor’s obligations to maintain such insurance. RTA shall have the right, but not the obligation, to prohibit Contractor from beginning performance under this contract until such certificates or other evidence that insurance has been placed in complete compliance with the above insurance requirements is received and approved by RTA.

Contractor shall provide certified copies of all insurance policies required above within ten (10) days of a written request from RTA.

- By requiring insurance herein, RTA does not represent that coverage and limits will necessarily be adequate to protect Contractor, and such coverage limits shall not be deemed as a limitation on Contractor's liability under the indemnities granted to RTA.
- Any subcontractors engaged by Contractor to perform the Work shall comply with these insurance and indemnification provisions and shall provide primary/noncontributory coverage to RTA as set forth herein.

8. Communications

Communications between the parties in connection with this Contract shall be in writing and, unless otherwise stated, shall be effective on receipt. Telephone calls may be used to expedite communications but shall not be official communication unless confirmed in writing. Electronic communications shall be effective upon receipt by the non-sending party. RTA and Contractor shall each designate a Project Manager who shall be the recipient of all communications hereunder. The parties may also designate other individuals as recipients for specific types of notices or communications and either party may change such designees at any time upon ten (10) days' prior written notice to the other party

9. Assignability

The terms and provisions of the Contract Documents shall be binding upon RTA and the Contractor and their respective partners, successors, heirs, executors, administrators, assigns and legal representatives. The rights and obligations of the Contractor under the Contract may not be transferred, assigned, sublet, mortgaged, pledged or otherwise disposed of or encumbered in any way. The Contractor may subcontract a portion of its obligations to other firms or parties but only after having obtained the written approval by RTA of the subcontractor, which approval shall not be unreasonably withheld. RTA may assign its rights and obligations under the Contract to any successor to the rights and functions of RTA or to any governmental agency to the extent required by applicable laws and governmental regulations or to the extent RTA deems necessary or advisable under the circumstances.

Should RTA agree to the assignment of a contract, Contractor shall be responsible for all associated costs, including all RTA's legal fees. The total expense will be deducted from the Contractor's invoice.

10. Subcontract Approval

RTA shall have the right to approve or disapprove all subcontracts in accordance with the following provisions. As used in this clause, the term "subcontract" includes subcontractors and major suppliers of material or services to the Contractor. Contractor shall notify RTA reasonably in advance of entering any subcontract if Contractor's procurement system has not been approved by RTA and if the subcontract:

- Is to be a cost reimbursement, time and materials, or labor-hour contract, which, is estimated to involve an amount more than ten thousand dollars ($10,000) including any fee.
- Is expected to exceed one hundred thousand dollars ($100,000); or
- Is one of a number of subcontracts, under this contract, with a single subcontractor for the same or related supplies or services which, in the aggregate, are expected to exceed one hundred thousand dollars ($100,000).

The advance notification required by the above shall include a description of the supplies or services to be called for by the subcontract.

Identification of the proposed subcontractor and an explanation of why and how the proposed subcontractor was selected including the competition obtained: The proposed subcontract price, together with Contractor's cost or price analysis thereof; the subcontractor's current, complete and accurate cost or pricing data and Certificate of Current Cost or Pricing Data, when such data and certificates are required by other provisions of this contract to be obtained from the subcontractor; Identification of the type of

subcontract to be used; and a memorandum of negotiation, which sets forth the principal elements of the subcontract price negotiations. A copy of this memorandum shall be retained in Contractor's file for use by the RTA's reviewing authorities. The memorandum shall be in sufficient detail to reflect the most significant considerations controlling the establishment of initial or revised prices.

Contractor shall not enter any subcontract for which advance notification to RTA is required by this clause, without the prior written consent of RTA, if RTA, in its discretion, may ratify in writing any subcontract. Such ratification shall constitute the consent of RTA required by this paragraph.

Neither consent by RTA to any subcontract nor any provisions thereof nor approval of Contractor's procurement system shall be construed to be a determination of the acceptability of any subcontract price or of any amount paid under any subcontract or to relieve Contractor of any responsibility for performing this contract, unless such approval or consent specifically provides otherwise.

Contractor agrees that no subcontract placed under this contract shall provide for payment on a cost plus a percentage of cost basis. Strict compliance with the provisions of this paragraph shall be a condition or any reimbursement by RTA of the costs of subcontracts or material purchased by the Contractor.

11. Organizational Conflicts of Interest

The recipient agrees that it will not enter a procurement that involves a real or apparent organizational conflict of interest described as follows:

1) When It Occurs. An organizational conflict of interest occurs when the Project work, without appropriate restrictions on certain future activities, results in an unfair competitive advantage:
    a. To that Third Party Participant or another Third-Party Participant performing the Project work, and
    b. That impairs that Third Party Participant's objectivity in performing the Project work, or
2) Other. An organizational conflict of interest may involve other situations resulting in fundamentally unfair competitive conditions,
3) Disclosure Requirements. Consistent with FTA policies, the Recipient must disclose to RTA, and each of its Subrecipients must disclose to the Recipient:
    a. Any instances of organizational conflict of interest, or
    b. Violations of federal criminal laws, involving fraud, bribery, or gratuity violations potentially affecting the federal award, and
4) Failure to Disclose. Failure to make required disclosures can result in remedies for noncompliance, including debarment or suspension.

12. Prohibited Interests

No member of, or delegate to the Congress of the United States shall be admitted to any share or part of this contract or to any benefit arising therefrom.

No member, officer, trustee or employee of RTA or of a local public body during his/her tenure or one year thereafter shall have any interest, direct or indirect, in this contract or the proceeds thereof.

13. Compliance

The Contractor agrees to comply with all applicable federal, state and local laws in the conduct of work thereunder. The Contractor accepts full responsibility for payment of all unemployment compensation, insurance premiums, workers' compensation premiums, all income tax deductions, pension deductions, and all employees engaged by the Contractor for the performance of the work authorized by this agreement.

14. Waivers of Claims

The Contractor's obligation to perform the work and complete the project in accordance with the contract document shall be absolute. Neither payment by the RTA, nor the issuance of a list of work to be completed or corrected, nor any use or occupancy of the project or any part thereof by the RTA, nor any act of acceptance by the RTA shall constitute an acceptance of work not in accordance with the contract document nor shall it be to waive, to compromise, or to affect in any manner the liability of the contractor for any breach of contract, of warranty or of both contract and of warranty.

The making and acceptance of final payment shall constitute:

A waiver of all claims by the RTA against the contractor other than those arising from unsettled liens, from faulty or defective work appearing after final payment, or from failure to comply with the requirements of the contract document, or the terms of any special guarantees therein.

A waiver of all claims by the contractor against the RTA, other than those previously made in writing and still unsettled.

15. Quantity and Time of Delivery

Contractors shall make all deliveries in accordance with the time requirements and other terms and conditions set in all applicable specifications and special conditions.

In the event the good or service, delivered and installed (if applicable) by the Contractor, does not satisfy fully all of the specifications and all other requirements appearing in the contract documents, the RTA may reject the good or service or any portion, in which case the goods/services/equipment rejected shall be deemed not to have been delivered, and the RTA shall have the rights set forth in Article V of the contract, in addition to any other rights and remedies to which it may be entitled by law.

Further, if the good or service is delivered and installed incomplete or contain(s) any defective or damaged parts, said parts shall be removed and new parts shall be furnished. The new parts furnished, including the transportation charges for same plus the labor for removal and installation of said parts, shall be free of all costs to RTA. If RTA finds it necessary to perform any work that should have been done by the Contractor, the Contractor agrees to reimburse RTA all costs incidents thereto including material, labor and overhead.

In case the good or service under this contract shall be necessarily delayed because of strike, injunctions, government controls or by reason of any causes or circumstances beyond the control of the Contractor which could not reasonably have been foreseen by the Contractor, the time of completion of delivery shall be extended by a period determined by RTA.

Acceptance of the good or service shall not release the Contractor from liability for faulty workmanship or materials even after final payment has been made. The RTA shall have the right to reject all materials and workmanship that do not conform to the specifications. The Contractor shall not be relieved of any obligation to furnish materials and workmanship strictly in accordance with the specifications.

16. Time for Performance

Time is of the essence in the performance of this contract. The Contractor shall fully perform all its obligations, including, without limitation, the satisfactory performance of all work to be done, by no later than the delivery or completion date set forth in the Special Conditions and Contract Document. The Contractor and the RTA recognize it will be difficult to compute the RTA's damage resulting from unexcused delays in the performance of the contract, particularly since the RTA is not a profit-making entity. Accordingly, it is agreed that the RTA will have the right to recover liquidated damages for delay in the completion of this contract beyond the date specified and not subject to the contract excusable delays. Costs caused by delays or defective construction shall be borne by the party responsible thereafter.

Alternatively, if the delivery or performance is so delayed, the RTA may terminate the contract in whole or in part under the Termination for Cause clause in the contract document and in that event, the Contractor

shall be liable for fixed, agreed, liquidated damages accruing until the time the RTA may reasonably obtain delivery or performance of similar supplies or services.

The RTA may cancel the unfilled portion of the contract for default; purchase substitute requirements elsewhere; and recover from the Contractor any increased costs thereby incurred, together with all resulting incidental and consequential damages.

17. Warranty and Guarantee

All materials, specialties, equipment, parts and accessories supplied by the Contractor shall be of the same design and model as all equipment purchased under this specification. The Contractor shall assume all responsibility for these materials, specialties, parts, equipment and accessories whether manufactured by the Contractor or purchased by him from another source.

All specialties, parts, equipment or accessories that prove to be defective in normal operation within the above referenced period shall be replaced or repaired by the Contractor free of all cost to the RTA, including all materials, labor and transportation costs. Transportation of warranty replacement parts shall be by the fastest means possible, including airfreight if the part is of a size that can be reasonably shipped via airfreight.

18. Sensitive Security Information

Each third-party contractor must protect, and take measures to ensure that its subcontractors at each tier protect, “sensitive security information” made available during the administration of a third-party contract or subcontract to ensure compliance with 49 U.S. C. Section 40119(b) and implementing DOT regulations, “Protection of Sensitive Security Information,” 49 CRF Part 15, and with 49 U.S.C. Section 114(r) and implementing Department of Homeland Security regulations, “Protection of Sensitive Security Information,” 49 CFR Part 1520.

19. Liability of RTA

The contractor shall agree to save, keep, bear harmless and fully indemnify the RTA and all its employees or agents for damages, costs or expenses in law and equity including reasonable attorney fees, if any, that may at any time arise, or be set up, for any infringement of the patent rights of any person or persons in consequence of the use by RTA or by any of its employees or agents, of articles supplied under this contract. RTA will give to the contractor notice in writing ten (10) days after the RTA has received actual notice of the institution of any suit or proceeding and permit the contractor, through his counsel, to defend same and will give all needed information, assistance and authority to enable the contractor to do so.

By virtue of the provisions of Section 306.31 of the Ohio Revised Code, RTA is a political subdivision of the State of Ohio, a body corporate with all the powers of a corporation. It is understood and agreed that only the corporate entity, RTA, shall be liable hereunder.

20. Intellectual Property

Contractor shall assume the defense of all claims and suits against RTA, its officers, agents and employees for infringement of the patents, copyrights or trademarks of any person arising out of the use by RTA, its officers, agents and employees of any article supplied under this contract, and the Contractor shall indemnify and hold harmless RTA, its officers, agents and employees from any and all liability, loss or damage arising from such claims or suits, including attorney fees.

21. Covenant against Contingent Fees

Contractor warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, except bona fide employees or bona fide, established commercial or selling agencies maintained by Contractor for the purpose of securing business. For breach or violation of this warranty, RTA shall have the right to annul this contract without liability or, at its discretion, to deduct from the contract price or

consideration, or otherwise recover, the full amount of such commission, percentage, brokerage or contingent fee.

22. Indemnifications

Contractor shall indemnify and save harmless RTA, its trustees, officers and employees from and against all claims, suits, damages, injuries, deaths, costs, liability, damage and expense whether direct, consequential or incidental, for personal injury and for property damage, such loss, costs, liability, damage and expense arising out of, or resulting in whole or in part, directly or indirectly, from work or operations under the contract but not limited to the acts, errors, omissions and negligence of Contractor's employees and agents, except to the extent of liability imposed due to RTA's own negligence.

23. State Industrial Compensation

Contractor shall comply with the state law known as the Workers' Compensation Act, Chapter 4123, Ohio Revised Code as applicable, and shall pay into the State Insurance Fund the necessary premiums required by that Act to cover all employees furnishing the services purchased under the terms of this contract and under the control of Contractor and shall relieve RTA from any costs due to accidents or other liabilities mentioned in said Act. If Contractor is a self-insurer under the Ohio Workers' Compensation Act, and duly authorized as such by the Industrial Commission of Ohio, it shall tender to RTA proof of such status. Contractor shall, from time to time upon request, tender to RTA a certificate evidencing its compliance with the Workers' Compensation Act.

24. Independent Contractor

Contractor shall be and remain an independent contractor with respect to all service performed hereunder and agrees to and does hereby accept full and exclusive liability for the payment of any and all contributions or taxes for Social Security, unemployment insurance, or old age retirement benefits, pensions, or annuities now or hereafter imposed under any state or federal law which are measured by the wages, salaries, or other remuneration paid under this contract, and further agrees to indemnify and save harmless RTA from any such contributions or taxes or liability thereof.

25. Safety

The Contractor should be aware that RTA is a constantly operating organization, with activity 24 hours a day, seven days a week. It is the intention of the RTA to protect RTA employees, customers and property from harm due to Contractor activity, and to reduce RTA’s liability exposure limits regarding safety and environmental infractions.

During the pre-construction or post-award meeting, the RTA will provide upon request RTA’s System-Wide Safety Manual and any additional required information to assure that contractors comply with RTA's safety rules. In addition, the RTA expects all contractors and subcontractors to comply with and abide with all applicable regulatory standards. Further, no laborer or mechanic will be required to work in surroundings or under working conditions that are unsanitary, hazardous, or dangerous, as determined under the standards established by the Secretary of Labor. Some special and unique safety and environmental concerns found at RTA and incumbent upon the contractor and sub-contractor include:

- RTA is a 24-hour per day operation.
- Multiple sized vehicles move about the interior and exterior of most buildings, 24 hours per day. Please be advised that set traffic patterns have been established and must be followed.
- Operators of all equipment are expected to be certified to operate appropriate equipment.
- Restrictive rules apply to the running of engines inside all buildings.
- Restrictive storm water pollution rules apply.
- Material safety data sheets must be provided for all materials used. Specific notification is required if a product to be used on the job has been classified as an “extremely hazardous material”.
- Building evacuation procedures.
- Fire safety and prevention procedures.
- First aid procedures.
- Hazardous material safety

26. Security Measures

All contractors are required to display an identification badge supplied by RTA while on RTA premises. Badges must be worn where they can be seen. This requirement applies to every employee of all contractors and/or subcontractors. All contractors' employees are also required to wear clothing which identifies the company for which they work (i.e., uniform, hard hat, jacket, etc.). Badges must be obtained from the Project Manager and must be returned upon completion of the project. A fee will be charged for any badges that are lost or not returned and will be deducted from the final project invoice.

27. Contract Changes

No change to the contract shall be made unless the RTA gives prior written approval. The Contractor shall be liable for all costs resulting from, and/or for satisfactorily correcting any change in the work not authorized by the RTA in writing.

The Contractor shall submit to the RTA a detailed pricing and schedule proposal for the work to be performed under the change order. The proposal may be accepted by the RTA or may be modified by negotiations between the Contractor and RTA. A change order amendment shall be executed in writing by both parties. Disagreements that cannot be resolved within negotiations shall be resolved in accordance with the contract "Disputes" clause. Regardless of any disputes, the Contractor shall proceed with the work ordered, provided the Contractor has obtained the prior concurrence of RTA.

28. Duty to Inform

If at any time during the performance of this contract, the Contractor becomes aware of actual or potential problems, fault defect in the project or any nonconformance with any contract document, federal, state or local law, rule or regulation, the Contractor shall give immediate notice thereof to the RTA's RTA Title.

"General Decision Number: OH20250093 04/25/2025

Superseded General Decision Number: OH20240093

State: Ohio

Construction Type: Building

County: Montgomery County in Ohio.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $17.75 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2025.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $13.30 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2025.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2025
1	02/07/2025

2 02/14/2025
3 03/14/2025
4 04/25/2025

ASBE0008-010 03/01/2024

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR	$ 34.23	21.94

BROH0022-005 06/01/2024

	Rates	Fringes
BRICKLAYER	$ 33.30	18.28

BROH0022-011 07/01/2024

	Rates	Fringes
TILE FINISHER	$ 28.28	11.05

ELEC0082-004 12/02/2024

	Rates	Fringes
ELECTRICIAN	$ 38.00	22.49

ELEV0011-002 01/01/2025

	Rates	Fringes
ELEVATOR MECHANIC	$ 57.41	38.435+a+b

PAID HOLIDAYS:

a. New Year's Day, Memorial Day, Independence Day, Labor Day, Vetern's Day, Thanksgiving Day, the Friday after Thanksgiving, and Christmas Day.

b. Employer contributes 8% of regular hourly rate to vacation pay credit for employee who has worked in business more than 5 years; 6% for less than 5 years' service.

ENGI0018-034 05/01/2024

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Crane	$ 44.14	16.41

ENGI0066-045 06/01/2017

	Rates	Fringes
POWER EQUIPMENT OPERATOR		
Forklift	$ 28.87	19.66
Grader/Blade	$ 32.42	19.66
Mechanic	$ 32.92	19.66

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* IRON0044-020 06/01/2024

	Rates	Fringes

IRONWORKER, ORNAMENTAL.....$ 35.37 23.60

IRON0290-006 06/01/2024

	Rates	Fringes
IRONWORKER (Reinforcing and Structural).....	$ 35.39	24.35

LABO1410-005 04/01/2024

	Rates	Fringes
LABORER		
Asbestos Abatement (Removal from Ceilings, Floors, and Walls).....	$ 31.65	12.95
Mason Tender - Brick.....	$ 32.25	12.95

PAIN0249-005 05/01/2024

	Rates	Fringes
PAINTER (Brush and Roller).....	$ 27.15	13.64

PAIN0387-002 11/01/2023

	Rates	Fringes
GLAZIER.....	$ 31.95	18.20

PLUM0050-009 07/01/2024

	Rates	Fringes
PIPEFITTER (Excludes HVAC Pipe Installation).....	$ 49.70	30.76

PLUM0162-008 06/01/2024

	Rates	Fringes
PLUMBER (HVAC Pipe Installation Only).....	$ 43.05	27.18

ROOF0042-001 08/01/2024

	Rates	Fringes
ROOFER.....	$ 33.00	19.42

SFOH0669-009 01/01/2025

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers).....	$ 45.11	28.08

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* UAVG-OH-0021 01/01/2019

	Rates	Fringes
OPERATOR: Oiler.....	$ 27.56	16.37

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* UAVG-OH-0025 01/01/2018

	Rates	Fringes
SHEET METAL WORKER, Excludes HVAC Duct and Unit Installation	$ 28.10	23.41

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* UAVG-OH-0031 01/01/2018

	Rates	Fringes
BRICKLAYER: TILE SETTER	$ 26.09	12.30

SUOH2012-095 08/29/2014

	Rates	Fringes
CARPENTER	$ 21.59	5.70
CEMENT MASON/CONCRETE FINISHER	$ 26.07	12.34
DRYWALL HANGER AND METAL STUD INSTALLER	$ 21.02	4.21
FORM WORKER	$ 22.41	9.01
LABORER: Common or General	$ 20.87	5.92
LABORER: Mason Tender - Cement/Concrete	$ 22.95	8.60
LABORER: Pipelayer	$ 23.98	8.58
OPERATOR: Backhoe/Excavator/Trackhoe	$ 33.36	6.13
OPERATOR: Bobcat/Skid Steer/Skid Loader	$ 30.26	12.58
OPERATOR: Bulldozer	$ 26.01	4.95
OPERATOR: Loader	$ 29.99	12.80
OPERATOR: Paver (Asphalt, Aggregate, and Concrete)	$ 30.28	13.29
OPERATOR: Roller	$ 28.25	12.61
PAINTER: Spray	$ 22.78	12.40
PLUMBER, Excludes HVAC Pipe Installation	$ 26.21	12.51
SHEET METAL WORKER (HVAC Duct and HVAC Unit Installation Only)	$ 24.28	10.50
TRUCK DRIVER: Dump (All Types)	$ 22.08	11.51

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classifications and wage rates that have been found to be prevailing for the type(s) of construction and geographic area covered by the wage determination. The classifications are listed in alphabetical order under rate identifiers indicating whether the particular rate is a union rate (current union negotiated rate), a survey rate, a weighted union average rate, a state adopted rate, or a supplemental classification rate.

Union Rate Identifiers

A four-letter identifier beginning with characters other than ""SU"", ""UAVG"", ?SA?, or ?SC? denotes that a union rate was prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2024. PLUM is an identifier of the union whose collectively bargained rate prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2024 in the example, is the effective date of the most current negotiated rate.

Union prevailing wage rates are updated to reflect all changes over time that are reported to WHD in the rates in the collective bargaining agreement (CBA) governing the classification.

Union Average Rate Identifiers

The UAVG identifier indicates that no single rate prevailed for those classifications, but that 100% of the data reported for the classifications reflected union rates. EXAMPLE: UAVG-OH-0010 01/01/2024. UAVG indicates that the rate is a weighted union average rate. OH indicates the State of Ohio. The next number, 0010 in the example, is an internal number

used in producing the wage determination. The date, 01/01/2024 in the example, indicates the date the wage determination was updated to reflect the most current union average rate.

A UAVG rate will be updated once a year, usually in January, to reflect a weighted average of the current rates in the collective bargaining agreements on which the rate is based.

Survey Rate Identifiers

The ""SU"" identifier indicates that either a single non-union rate prevailed (as defined in 29 CFR 1.2) for this classification in the survey or that the rate was derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As a weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SUFL2022-007 6/27/2024. SU indicates the rate is a single non-union prevailing rate or a weighted average of survey data for that classification. FL indicates the State of Florida. 2022 is the year of the survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 6/27/2024 in the example, indicates the survey completion date for the classifications and rates under that identifier.

?SU? wage rates typically remain in effect until a new survey is conducted. However, the Wage and Hour Division (WHD) has the discretion to update such rates under 29 CFR 1.6(c)(1).

State Adopted Rate Identifiers

The ""SA"" identifier indicates that the classifications and prevailing wage rates set by a state (or local) government were adopted under 29 C.F.R 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

1) Has there been an initial decision in the matter? This can be:

a) a survey underlying a wage determination
b) an existing published wage determination
c) an initial WHD letter setting forth a position on a wage determination matter
d) an initial conformance (additional classification and rate) determination

On survey related matters, initial contact, including requests for summaries of surveys, should be directed to the WHD Branch of Wage Surveys. Requests can be submitted via email to davisbaconinfo@dol.gov or by mail to:

Branch of Wage Surveys

Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

Regarding any other wage determination matter such as conformance decisions, requests for initial decisions should be directed to the WHD Branch of Construction Wage Determinations. Requests can be submitted via email to BCWD-Office@dol.gov or by mail to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via email to dba.reconsideration@dol.gov or by mail to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210.

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END OF GENERAL DECISION"