

PROJECT MANUAL

GWINNETT TECHNICAL COLLEGE



TCSG - 361 BUILDING 100 RENOVATION AND EXPANSION

**5150 SUGARLOAF PARKWAY
LAWRENCEVILLE, GEORGIA 30043**

DESIGN DEVELOPMENT (CE)

NOVEMBER 06, 2020



**ARCHITECTURE PLANNING INTERIORS
342 MARIETTA STREET UNIT 3
ATLANTA, GEORGIA 30313**

**GWINNETT TECHNICAL COLLEGE
TCSG 361 BUILDING 100 RENOVATION AND EXPANSION**

SEALS PAGE

The following design professional, by affixing their seal and signature on this page certify that they have personally prepared, or have prepared under their direct supervision, their respective portion of the Contract Documents.

Parties include: Architect-of-Record, Civil Engineer, Structural Engineer, Mechanical Electrical Plumbing and Fire Protection Engineer.

Architect of Record	Structural Engineer	MEPFP Engineer
	Civil Engineer	

END OF SEALS PAGE

**GWINNETT TECHNICAL COLLEGE
BUILDING 100 EXPANSION AND RENOVATION**

PROJECT TEAM DIRECTORY

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**GWINNETT TECHNICAL COLLEGE
BUILDING 100 EXPANSION AND RENOVATION**

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BUILDING 100 EXPANSION AND RENOVATION**

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BUILDING 100 EXPANSION AND RENOVATION

SIZEMORE GROUP LLC
PN 20051GWTCOL

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**APPENDIX: Hazardous Building Material Report
Liquid Fluid Soil Sampling**

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SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. General requirements that apply to the implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Related Sections
 - 1. Division 01 – Building Enclosure Commissioning
 - 2. Division 22 – Plumbing
 - 3. Division 23 – Mechanical
 - 4. Division 26 – Electrical

1.2 RELATED DOCUMENTS

- A. BOD documentation are included by reference for information only.
- B. Drawings and general provisions of the contract including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.3 DEFINITIONS

- A. Basis of Design (BOD): A document that records concepts, calculations, system selection decisions, and product selections used to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- B. Commissioning: The systematic process of assuring by verification and documentation, from the design phase through occupancy that all facilities perform interactively in accordance with the design documentation and intent, and in accordance with the owner's operational needs, including preparation of operational personnel.
- C. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This is an overall plan that provides the structure, schedule, and coordination planning for commissioning. As construction progresses, the CxA will update the plan, which includes details of:
 - 1. Commissioning scope
 - 2. Systems to be commissioned
 - 3. Rigor of commissioning
 - 4. Team contact information

5. Roles and responsibilities of all parties
 6. Communication and reporting protocols
 7. Commissioning overview and details of submittal activities
 8. Construction observation, checklists, and start-up activities
 9. Process for dealing with deficiencies
 10. Test procedure development and execution
 11. Description of summary report, progress and reporting logs
- D. CxA: Commissioning Authority.
- E. Construction Start-up: The initial activation or energizing of equipment or systems for the purpose of demonstrating completeness of installation, utility connections, performance, system operations, and ability to perform for its specified purpose.
- F. Functional Performance Test (FPT) Procedures: This written protocol defines methods, personnel, and expectations for test conducted on components, equipment, assemblies, systems, and interfaces among systems. Tests clearly described the test prerequisites, required test conditions, individual systematic test procedures, expected system response and acceptance criteria for each procedure, actual response or findings, and any pertinent discussion. Test procedures differ from testing requirements found in the specifications, which describe what modes and features are to be tested and verified and under what conditions. Test procedures describe the step-by-step method of how to test. Simple checklists may be appropriate for testing simple components, but dynamic testing of interfacing components requires more detailed procedures and forms.
- G. HVAC: The Heating, Ventilating and Air Conditioning system called for by the Contract Documents.
- H. Issues Log: The purpose of this log is to provide a method for tracking and resolution of deficiencies discovered as a result of the commissioning process. This list also includes the current disposition of issues and the date of final resolution as confirmed by the Commissioning Authority. Deficiencies are defined as those issues where products, execution or performance do not satisfy the Specifications and/or the design intent. The Issues Log will be created and managed by the commissioning Authority.
- I. Pre-functional Checklists: Pre-functional checklists are forms developed by the contractor, equipment manufacturer, or CxA as applicable and used by the contractor to verify that specified systems and components are complete and correctly installed, ready for start-up and functional testing. These Checklists are supplemental to the equipment manufacturer's standard installation instructions and pre-start up forms. The Completed Checklists along with the equipment manufacturer's pre-start-up forms must be submitted by the contractor PRIOR to startup of the equipment. Equipment specified to have factory start-up performed must have the applicable Checklist filled out by the vendor and submitted by the contractor. After the Checklists have been approved and start-up has occurred, the contractor can begin their pre-checkout of the functional operations of the equipment and systems prior to validation by the CxA during the Functional Testing.
- J. Pre-functional Testing: The process of starting the equipment and systems utilizing

vendor/contractor startup and installation pre-functional checklists in coordination with the CxA's pre-functional documentation to ensure systems are operating in compliance with the contract documents, specifications and building automation system sequences, prior to functional validation by the CxA

- K. Start Up: The initial activation or energizing of equipment or systems for the purpose of demonstrating completeness of installation, utility connections, performance, system operations, and ability to perform for its specified purpose.
- L. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity represented, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by Owner:
 - 1. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The CxA has been engaged under a separate contract.
Total Systems Commissioning, Inc.
Contact: Richard Dutro, CxA, BCxP, CPD, LEED BD+C
404.457.3768 mobile
ddutro@tscx.org
 - 2. Representatives of the facility user and operation and maintenance personnel.
 - 3. Architect and engineering design professionals.

1.5 OWNER'S RESPONSIBILITIES

- A. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- B. Provide the BOD documentation, prepared by Architect / Engineer and approved by Owner, to the CxA for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
- C. Assist in reviewing selected submittals.
- E. Assist in construction observation, verifying completion of construction checklists and observing start-up.
- F. Participate in or witness testing, within pre-established lines of responsibility and authority.

- G. Review O&M and systems manual.
- H. Participate in training and document acceptance of training.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
 1. Provide input into Commissioning Plan and assist to execute the Plan.
 2. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 3. Cooperate with the CxA for resolution of issues recorded in the Deficiency and Resolution Log. Update log as items are completed and provide to CxA on a regular basis.
 4. Attend commissioning team meetings.
 5. Integrate and coordinate commissioning process activities with construction schedule.
 6. Review, accept and complete construction pre-functional checklists provided by the CxA prior to equipment start-up.
 7. Complete construction completion checklists and pre-functional checklists as Work is completed and provide to the Commissioning Authority on a regular basis.
 8. Review and accept commissioning functional test procedures provided by the Commissioning Authority.
 9. Complete commissioning functional test procedures with witnessing by CxA.
 10. Ensure subcontractor's commissioning work is completed and cooperate with CxA in executing the commissioning plan.
 11. Respond to questions and issues raised by CxA.
 12. Resolve issues identified during commissioning and coordinating correction of identified deficiencies.
 13. Provide equipment, system, and assembly data needed by CxA.
 14. Perform specified training.
 15. Coordinate with other trades as necessary to facilitate a smooth and complete commissioning process.
 16. Perform and document tests as specified in the mechanical and electrical sections.
 17. Participate in resolving issues within their scope identified during commissioning.
 18. Provide required documentation for systems manuals and commissioning reports.
 19. Provide labor, materials, and tools as required to assist in the commissioning process for removal / replacement of electrical panel covers, ceiling tiles, access doors, etc. including ladders, lift, etc.
 20. Perform off-season testing with CxA for verification of HVAC system operation in season opposite project turn over to Owner, correct any operational issues found during testing.

1.7 COMMISSIONING AGENT (CxA) RESPONSIBILITIES

- A. Organize and lead the commissioning team. Coordinate with the contractor, design professionals, and Owner for commissioning activities with the construction schedule.

- B. Provide commissioning plan and update through construction.
- C. Convene commissioning team meetings.
- D. Provide Project-specific construction checklists, forms, and commissioning functional test procedures.
- E. Verify the execution of commissioning process activities using random sampling. Verification will include, but is not limited to, equipment submittals, construction forms and checklists, training, operating and maintenance data, tests, and test reports. When a random sample does not meet the requirement, the CxA will report the failure in the Deficiency and Resolution Log. Coordinate re-testing with Contractor as required for final acceptance.
- F. Prepare and maintain the Deficiency and Resolution Log and track completion of items noted.
- G. Prepare and maintain completed pre-functional test forms, equipment start-up forms, and Functional test forms.
- H. Witness systems, assemblies, equipment, and component startup including pipe flushing and cleaning activities.
- I. Review Test and Balance execution plan. Witness major HVAC component air and water balancing activities. Review final Test and Balance Report.
- J. Compile test data, site observation reports, and certificates and include them in the commissioning report.
- K. Perform deficiency log updates during the construction and acceptance testing phases with contractor assistance. Perform final sign off of deficiency log prior to the Owner's receipt of the final Certificate of Occupancy

PART 2 – EQUIPMENT TO BE COMMISSIONED

2.1 COMMISSION THE FOLLOWING SYSTEMS:

- 1. Building Automation Systems
- 2. HVAC Equipment
- 3. Electrical Equipment
- 4. Plumbing systems
- 5. Building Envelope (See Specification 01 91 13)
- 6. Test and Balance Review

PART 3 – EXECUTION

3.1 COMMISSIONING OBJECTIVE

- A. The commissioning objective focuses on documented confirmation that a facility fulfills the specified performance requirements for the building owner, occupants, and operators. To reach this objective, it is necessary to: clearly document the Basis of Design, including performance and maintainability; and verify and document compliance with these criteria throughout design, construction, acceptance, initial operation, off-season testing, and Warranty phases. Specific goals for commissioning include:
1. Providing documentation and assist in Owner selection of tools to improve quality of deliverables (e.g., forms, tracking software, performance calculation tools).
 2. Verifying and documenting that systems and assemblies perform according to the BOD by end of construction.
 3. Verifying that adequate and accurate system and assembly documentation is provided to owner.
 4. Verifying that operation and maintenance personnel and occupants are properly trained.
 5. Providing a uniform and effective process for delivery of construction projects.
 6. Using quality-based sampling techniques to detect systemic problems.
 7. Verifying proper coordination among systems and assemblies, and among all contractors, subcontractors, vendors, and manufacturers of furnished equipment and assemblies.
 8. Ensuring occupation of the building occurs with proper building systems operation to virtually eliminate contractor call-backs to correct system deficiencies.
 9. Completion of Punch List work prior to building occupation.
 10. Energy efficient operation of the building systems.

3.2 SUBMITTALS

- A. The Contractor shall provide the CxA with information required to facilitate the commissioning process from a written request. These requests may be integrated into the normal submittal process. At minimum, the request will include the normal submittals and shop drawings, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, and performance data, any performance test procedures, control drawings and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA. The CxA will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment, adequacy for developing test procedures and for O&M issues. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The CxA will provide in their review items unclear, missing, or areas that are not in conformance with Contract Documents.
- B. The Contractor and Architect shall provide additional design narrative information requested by the CxA, depending on the completeness of the Design Record documentation and sequences provided with the Specifications.
- C. These submittals to the CxA do not constitute compliance for O&M manual documentation.

The O&M manuals are the responsibility of the contractor.

3.3 QUALITY ASSURANCE

- A. Test Equipment.
1. All standard testing equipment required for the Contractor to perform installation, start-up and initial checkout and required functional performance testing shall be provided by the Contractor.
 2. Special equipment, tools and instruments, only available from vendor, specific to a piece of equipment, required for testing equipment according to the Contract Documents shall be included in the base bid price to the Contractor and left on site, except for stand-alone data logging equipment that may be used by the CxA.
 3. Data logging equipment and software required to test the HVAC and mechanical equipment will be provided by the CxA, but shall not become the property of the Owner.
 4. Data logging and test equipment required to test the electrical systems shall be provided by the Contractor but shall not become the property of the Owner. Instruments must be calibrated in accordance with the following frequency:
 - a. Field Instruments: Analog, 6 months maximum, Digital, 12 months maximum
 - b. Laboratory Instruments: 12 months
 - c. Leased specialty equipment: 12 months where accuracy is guaranteed by leaser.
- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the specifications. If not otherwise given, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

3.4 CONSTRUCTION CHECKLISTS, START-UP, AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment and assemblies to be commissioned.
- B. Construction Checklists. The CxA develops new or adapts existing representative construction checklists and procedures for commissioned equipment and assemblies. A sample checklist is provided in Attachment 1 of the project manual.
- C. Start-up and Initial Checkout Plan. The Contractor develops installation, start-up and initial checkout plans for equipment and assemblies with assistance from the CxA. 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 and that the systems are ready for functional testing.
1. The start-up and initial checkout plan consists of:
 - a. The manufacturer's installation instructions.
 - b. The vendor's field checkout and start-up sheets.

- c. The construction checklists provided by the CxA.
2. Manufacturer's Installation Instruction consist of the manufacturer's detailed start-up and checkout procedures copied from the O&M manual or shipped with the equipment. Each individual instructional procedure in these documents without a checkbox will have a line or box added in the margin for initialing when completed.
3. Vendor field checkout sheets consist of the manufacturer's field checkout and start-up sheets normally used by the manufacturer for start-up.
4. Construction Checklists consist of procedures and checks to ensure systems and assemblies are ready for functional operation and are provided by the CxA to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks in the checklists and notes that trade on the checklist form.
 - a. Calibrations: The construction checklists will contain requirements for calibrations. The Contractor is responsible to calibrate all field-installed temperature, relative humidity, CO, CO₂ and pressure sensors and gages, and all actuators (dampers and valves) on all equipment using methods approved by the CxA. Sensors installed *in* the unit at the factory with calibration certification provided need not be field calibrated. Valve leak-by tests shall be conducted by the Contractor when shown on a construction checklist. All procedures used shall be fully documented on the construction checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
 - b. Point-to-point Checkout: Included in the checkout plan will be a point-to-point checkout of each control point tied to a central control system. Each point will be verified to be commanding, reporting and controlling according to its intended purpose. For each output, commands will be initiated and verified to be functioning by visually observing and documenting the status of the controlled device in the field (e.g., command lights or sound off, command cooling coil valve to full open, or command heating water pump off). For each input, the system or conditions will be perturbed to initiate the input response being tested and the response in the control system observed and recorded (e.g., high duct static pressure alarm).
5. The Contractor compiles the full installation, start-up and initial checkout plan and provides a signature block at the beginning of the plan covering the entire plan execution.
6. At the CxA's request, for complex systems or assemblies, the Contractor shall develop a custom narrative description of the proposed start-up or concealment process taking into account interactions and impacts on other systems, construction coordination and scheduling, indoor air quality, system cleanliness, equipment warranty, etc.
7. The Contractor submits the full plan to the CxA for review and approval. The Construction Manager may also review selected start-up plans.

D. Execution of Construction Checklists and Start-up.

1. Each piece of equipment or assembly being commissioned receives full construction checkout by the Contractor following the approved plan and forms. No sampling strategies are used. Only individuals that have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall initial or check that item off. It is not acceptable for non-witnessing supervisors to fill out the forms.
2. For dynamic mechanical or electrical equipment, the Contractor shall complete the pre-

- start procedures in the plan prior to starting equipment. For static assemblies the contractor shall complete pre-concealment procedures before concealing any assembly. The Contractor shall notify the CxA at least five days in advance of any equipment start-up or assembly concealment, providing the CxA a copy of the pre-start/pre-concealment sections of the installation and start-up plan at start-up.
3. The CxA shall observe installation, start-up and checkout of selected systems and assemblies. Procedures on the plans and checklists will be spot-checked by the CxA prior to functional testing.
 4. The Contractor and vendors shall execute start-up or concealment and provide the CxA with a signed and dated copy of the completed construction checklists and installation and start-up documentation. The Contractor shall clearly note any items that have not been completed and the plan for their completion.
 5. The Construction Checklist and other procedures from the plan for a given system or assembly must be successfully completed prior to formal functional performance testing of the equipment.
 6. The CxA reviews the documentation and identifies incomplete areas. Only two reviews are allowed by the CxA. Additional reviews required by the CxA due to Contractor not correctly completing the commissioning checklists will be outside the CxA scope and back charged to the Contractor.
 7. The Contractor shall correct all areas that are deficient or incomplete in the checklists in a timely manner.

3.5 FUNCTIONAL TESTING

- A. This sub-section applies to all commissioning functional testing for all divisions.
- B. The Contractor shall be responsible to fully test all systems and assemblies according to the specifications. The CxA will direct, witness and document the functional testing. The Contractor shall execute the tests.
- C. Testing Requirements. The functional testing requirements for HVAC and mechanical systems and equipment are found in section 15080. The CxA shall develop documentation forms for the HVAC and mechanical equipment testing during the construction phase of the project after approved equipment and control system shop drawings are available.
- D. Objectives and Scope:
 1. The objective of functional performance testing is to demonstrate that each system is operating according to the documented Owner Objectives and Contract Documents. For dynamic systems, functional testing facilitates bringing the systems from a state of initial operation to full dynamic operation. For static elements, functional testing verifies the performance of the assembly in its installed state under conditions specified in the testing requirements. Additionally, during the testing process, areas of deficient performance are identified and corrected.
 2. In general functional testing shall include testing each sequence in the sequence of operations, and other significant modes, sequences and control strategies not mentioned in the written sequences; including, but not limited to startup, shutdown, unoccupied and manual modes, modulation up and down the unit's range of capacity, power failure,

alarms, component staging and backup upon failure, interlocks with other equipment, and sensor and actuator calibrations. All interlocks and interactions between systems shall be tested. All larger equipment will be individually tested. Like units or assemblies that are numerous (many smaller rooftop packaged units, air terminal units, exhaust fans, etc.) may have an appropriate sampling strategy applied. Heating equipment should be tested during winter and air conditioning equipment should be tested during summer to demonstrate performance under near-design conditions.

- E. Development of Functional and Performance Test Procedures. The CxA obtains needed documentation: equipment specifications, testing requirements, start-up and initial start-up instructions, sequences of operation, and mechanical, electrical and control drawings and writes detailed step-by-step testing procedures to comply with the testing requirements. Prior to execution, the CxA will provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection.
- F. Functional Performance Test Procedure Format. 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 checklist and start-up 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. Formulas used in any calculations
 9. Required pre-test field measurements
 10. Instructions for setting up the test.
 11. Special cautions, alarm limits, etc.
 12. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
 13. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved.
 14. Signatures and date block for the CxA
- G. Functional and Performance Test Methods.
1. Functional testing and verification for most dynamic equipment shall be achieved by an appropriate combination of manual testing (persons manipulate the equipment and observe its function) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The testing requirements sections of the specification describe which methods shall be used for each test. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the Program Manager.
 2. Simulated Conditions. Simulating conditions other than by overwriting a 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. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate set point to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

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 Set points. Rather than overwriting sensor values, and when simulating conditions is difficult, altering set points to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout set point to be 2F above the current outside air temperature.
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. Much of this verification is completed during construction checklists and calibrations.
7. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Contractor 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 Contractor 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. The specific recommended sampling rates are specified with the testing requirements. It is noted that no sampling by the contractor is allowed in construction checklist execution.
9. Testing Order. In general, functional testing is conducted after construction checklists are complete and start-up has been satisfactorily completed. The control system is sufficiently tested and approved by the CxA before it is used for testing, adjusting and balancing or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing generally proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is verified.
10. Trend Logs and Monitoring. Trend logs required in the testing requirements will be set up and executed by the Contractor and provided to and analyzed by the CxA. Monitoring using data loggers will be conducted by the CxA as needed. Trend logs shall be compiled and transmitted to the CxA in a CSV or Excel format. PDF's and graphs are not acceptable. Trend logs and monitoring are conducted after manual testing and

subsequent trouble-shooting are complete and systems are in normal operation without frequent service shutdowns, etc.

- H. Problem Solving. The burden of problem solving is on the Contractor and the Architect, though the CxA may recommend solutions to problems found.

3.6 NON-CONFORMANCE AND APPROVAL OF FUNCTIONAL TESTS

A. Non-Conformance.

1. The CxA will record the results of the functional tests and trend logs or monitoring on the procedure or test form. All deficiencies or non-conformance issues shall be recorded on a master Issues Log kept by the CxA and reported directly to the Program Manager within two days of occurrence or sooner when scheduling and coordination require it. The Contractor, in consultation with the Architect when necessary, will determine the responsible party and a suitable plan for resolution. The CxA is notified of the resolution and documents it in the Issues Log.
2. The CxA is notified when the issue has been resolved and reschedules the test and the test is repeated.
3. Corrections of issues identified may be made during the tests at the discretion of the CxA and with the issue and resolution documented.
4. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Program Manager.
5. Cost of Retesting.
 - a. For a deficiency identified, not related to any construction checklist or start-up fault, the following shall apply: The CxA and GC will direct the retesting of the equipment once at no "charge" to the Contractor for their time. However, the CxA's and GC's time for a second retest will be charged to the Contractor.
 - b. The time for the CxA and GC to direct any retesting required because a specific *construction* checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be charged to the Contractor.
6. The Contractor shall respond in writing to the CxA and PM at least as often as commissioning meetings are being scheduled concerning the status of each outstanding issue identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
7. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

- B. Failure Due to Manufacturer Defect. For identical or near-identical components numbering more than ten (e.g., terminal units, diffusers, traps, valves, etc.): if 10%, 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 specification, all identical units may be considered unacceptable by the PM. In such case, the Contractor shall provide the PM

with the following:

1. Within one week of notification from the PM, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the PM and GC within two weeks of the original notice.
 2. Within two weeks of the original notification, the Contractor 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 will determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution will be installed by the Contractor and the PM, GC, CxA will be allowed to test the installations for up to one week, upon which the PM will decide whether to accept the solution.
 5. Upon acceptance, the Contractor 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.
- C. Approval and Acceptance. The CxA notes each satisfactorily demonstrated function on the functional test form. However, formal approval of an entire test form is not normally given. Functional approval or acceptance of a system is indicated after all testing and monitoring is complete and there are no outstanding issues for that equipment or assembly in the CxA's Issues Log.

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.
- B. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) specified in the testing requirements shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the Contractor, with facilities staff and the CxA witnessing. The Contractor shall make needed final adjustments to the O&M manuals and as-builts due to the testing results.
- C. Scheduled Deferred Tests: Specific tests such as thermography of the electrical distribution system are less meaningful in an unoccupied or partially occupied building. As such tests requiring occupancy loads will be scheduled in accordance to meeting desired occupancy conditions.

3.8 DOCUMENTATION

- A. Commissioning Plan: The Commissioning Plan is defined in this section and follows the

process outlined in the specifications. The CxA develops and updates the Commissioning Plan as construction progresses. The Specifications will take precedence over the Commissioning Plan.

- B. Schedule: The PM and Contractor work with the CxA using established protocols to schedule the commissioning activities. The PM and Contractor shall integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process. As construction progresses, more detailed commissioning schedules shall be developed. The Contractor shall provide a minimum of two weeks' notice prior to the date of testing to the CxA. In addition, the CxA and GC shall be notified 36 hours in advance when tests are canceled or rescheduled. The Contractor shall reimburse the CxA for labor and travel costs for a test that has either been canceled or rescheduled without required notice. The Contractor shall also reimburse the CxA for costs when a scheduled test cannot be completed due to failure of the Contractor to properly prepare for the test, including but not limited to:
1. Failure to schedule the test with all parties required to perform the test or with regulatory authorities required to witness the test.
 2. Failure to complete pre-start or start-up procedures or other work required as a prerequisite for execution of the test.
 3. Failure to have in place test equipment, support equipment, instrumentation, permits, or other ancillary equipment or systems required for successful execution of the test.
- C. Reporting and Documentation by the CxA
1. The CxA will provide regular reports of all issues and progress directly to the PM with increasing frequency as construction and commissioning progresses. Issues that are in the schedule critical path or which significantly affect budget or building performance will be reported within 2 days of identification.
 2. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.
 3. The CxA shall witness and document the results of all functional and performance tests using the specific procedural forms developed for that purpose. The CxA will include the filled out forms in the Commissioning Record.
 4. Commissioning Record. The CxA is responsible to compile, organize and index commissioning data by equipment and assembly into labeled, indexed and tabbed, three-ring binders and deliver it to the PM, to be included with the O&M manuals. Three copies of the manuals will be provided. The record will contain for all systems and assemblies together: the Summary Report, Issues Log, Commissioning Plan, progress reports, submittal reviews, construction observation reports, functional testing schedule. Then for each system or assembly: the sequence of operation, construction checklist, start-up report, functional and regulatory test and inspection records. And finally, the indexed and fully labeled trend log analysis of all systems.
 5. Summary Report. The summary commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment or assembly, the report should contain the disposition of the CxA regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:

- a. Meeting the equipment specifications
 - b. Installation
 - c. Functional performance and efficiency
 - d. Equipment O&M manual documentation
 - e. Operator training.
All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.
6. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

END OF SECTION 019100

SECTION 01 9113 – BUILDING ENCLOSURE COMMISSION REQUIREMENTS

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 building enclosure Cx process requirements for the above- and below-grade systems and assemblies:
 - 1. Horizontal and Vertical Waterproofing.
 - 2. Opaque Walls.
 - 3. Roofs.
 - 4. Openings.
 - 5. Interfaces.
- B. Related Sections:
 - 1. Section 019100 "General Commissioning Requirements" for general requirements for Cx processes including definitions, Cx team membership, Owner's responsibilities, Contractor's responsibilities, and CxA's responsibilities.

1.3 DEFINITIONS

- A. Building Enclosure: Materials, components, systems, and assemblies intended to provide shelter and environmental separation between interior and exterior, or between two or more environmentally distinct interior spaces in a building or structure. The building enclosure includes, but is not limited to, exterior walls, above and below grade, and roof assemblies.
- B. Cx: Commissioning, as defined in Section 109100 "General Commissioning Requirements."
- C. CxA: Commissioning Authority, as defined in Section 019100 "General Commissioning Requirements."
- D. First-Installation Mockups: Initial installation of specific enclosure materials, components, systems, and assemblies that are part of Work.
- E. Integrated Exterior Mockups: Integrated mockups of the exterior enclosure erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
- F. Laboratory Mockups: Full-size physical assemblies constructed at testing facility

- G. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- H. Water Penetration: Visible evidence of uncontrolled water penetration on or adjacent to the test specimen in a location not intended to collect and drain water to the building exterior.

1.4 INFORMATION SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Construction Checklists: Draft Construction Checklists will be created by CxA for Contractor review.
- C. Cx Process Submittals:
 - 1. Shop Drawings: For mockups, including elevations, plans, sections, and full-size details. Show interface conditions, interconnections, and terminations.
 - 2. Testing Program: Developed specifically for Project.
 - 3. Test Reports: Prepared by a qualified testing agency for each test.
 - 4. Record Drawings: As-built drawings of mockups showing changes made during testing.
 - 5. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For building envelope systems and components to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.
- B. Build mockups to evaluate constructability and performance, and demonstrate the coordination of trades and sequencing of work necessary to ensure functional and integrated performance of materials, components, systems, assemblies, and interfaces.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 2. Notify Architect and CxA seven days in advance of the dates and times when mockups will be constructed and tested.
- C. Laboratory Mockups: Build at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.
- D. Integrated Exterior Mockups: Build at Project site on site at locations as directed by Architect.

- E. First Installation Mockups: Prepare each major exterior enclosure system for testing when first installed and before proceeding with construction of additional similar assemblies. If in compliance, work may remain as part of the completed construction.
 - 1. Wall Mockups: Extend one full structural bay wide by one full story high plus additional height to connect to assemblies below and above. Include a typical wall to interior floor slab connections.
 - 2. Roof Mockups: Include parapet or roof edge conditions, flashings, and typical pipe, dunnage, and similar penetrations.
 - a. Minimum Size: 100 sq. ft. (9 sq. m).

- F. Mockups specified for quality assurance and control in the following sections may be combined with Cx mockups for testing purposes.
 - 1. Section 033300 "Architectural Concrete."
 - 2. Section 042113 "Unit Masonry."
 - 3. Section 075423 "TPO Roofing."
 - 4. Section 084113 "Aluminum Framed Entrances & Storefronts."
 - 5. Section 084413 "Glazed Aluminum Curtain Walls."

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLIST REVIEW

- A. Review and provide written comments on draft Construction Checklists. CxA will create required draft Construction Checklists and provide them to Contractor.
- B. Return draft Construction Checklist review comments within 10 days of receipt.
- C. When review comments have been resolved, CxA will provide final Construction Checklists, marked "Approved for Use, (date)."
- D. Use only Construction Checklists, marked "Approved for Use, (date)."

3.2 GENERAL TESTING REQUIREMENTS

- A. If tests cannot be completed because of a deficiency outside the scope of the building enclosure systems, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
- B. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- C. Coordinate schedule with, and perform Cx activities at the direction of the CxA.

3.3 INTEGRATED EXTERIOR MOCKUP TESTING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Integrated Exterior Mockup Testing Program: Perform the following tests in the following order:
 - 1. Smoke Testing: ASTM E 1186 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - 2. Opaque Wall Air Infiltration: ASTM E 783 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Maximum air leakage of 0.25 cfm/sq. ft.
 - 3. Window Air Infiltration: ASTM E 783 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Maximum air leakage of 0.3 cfm/sq. ft.
 - 4. Water Penetration under Static Pressure: ASTM E 1105 with minimum uniform static-air-pressure differential of 8.0 lbf/sq. ft. (384 Pa).
 - a. No evidence of water penetration.
 - 5. Water Penetration under Dynamic Pressure: AAMA 501.1 at a test pressure of 8.0 lbf/sq. ft. (384 Pa).
 - a. No evidence of water penetration.
 - 6. Pull-off Strength of Adhered Air Barriers: ASTM D 4541 as modified by ABAA.
 - a. Minimum 16 lbf/sq. in. (110 kPa) adhesion to substrate.
 - 7. Pull Test for EIFS: ASTM E 2359.
 - a. Refer to drawings for design pressures applicable.
 - 8. Sealant Durability: ASTM C 794.
 - a. 15 lb./in minimum.
 - 9. Outdoor-Indoor, Sound-Transmission Loss: ASTM E 966.
 - a. 35 dB reduction outdoor to indoor.
 - b. Refer to Hartsfield Jackson Part 150 Noise Program for DNL contour maps.

3.4 FIRST-INSTALLATION MOCKUP TESTING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Wall Mockups: Perform the following tests in the following order:
 - 1. Smoke Testing: ASTM E 1186 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - 2. Opaque Wall Air Infiltration: ASTM E 783 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Maximum air leakage of 0.25 cfm/sq. ft.
 - 3. Window Air Infiltration: ASTM E 783 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Maximum air leakage of 0.3 cfm/sq. ft.
 - 4. Water Penetration under Static Pressure: ASTM E 1105 with minimum uniform static-air-pressure differential of 8.0 lbf/sq. ft. (384 Pa).
 - 5. Water Penetration under Dynamic Pressure: AAMA 501.1 at a test pressure of 8.0 lbf/sq. ft. (384 Pa).
 - a. No evidence of water penetration.
 - 6. Pull-off Strength of Adhered Air Barriers: ASTM D 4541.
 - a. Minimum 16 lbf/sq. in. (110 kPa) adhesion to substrate.

7. Pull Test for EIFS: ASTM E 2359.
 - a. Refer to drawings for design pressures applicable.
 8. Sealant Durability: ASTM C 794.
 - a. 15lb/in minimum.
 9. Outdoor-Indoor, Sound-Transmission Loss: Per ASTM E 1332, determined by testing according to ASTM E 966.
 - a. 35 dB reduction outdoor to indoor.
- C. Roof Mockup: Perform the following tests in the following order:
1. Air Leakage Site Detection: ASTM E 1186.
 - a. No evidence of air penetration.
 2. Flood Testing of Horizontal Waterproofing: ASTM D 5957.
 - a. No evidence of water penetration for a minimum 48 hours.
 3. Water-Spray Test: AAMA 501.2.
 - a. No evidence of water penetration.
 4. Electronic Leak Detection.
 - a. No evidence of water penetration.
- D. Horizontal Below-Grade Waterproofing and Slab-on-Grade Mockups: Perform the following tests in the following order:
1. Water Penetration: ASTM D 5957.
 - a. No evidence of water penetration.
 2. Water-Spray Test: AAMA 501.2 for terminations and interface conditions.
 - a. No evidence of water penetration.
 3. Electronic Leak Detection.
 - a. No evidence of water penetration.
- E. Vertical Below-Grade Waterproofing Mockups: Perform the following tests in the following order:
1. Water Penetration: ASTM E 1105 without air-pressure differential.
 - a. No evidence of water penetration.
 2. Water-Spray Test: AAMA 501.2.
 - a. No evidence of water penetration.
- F. Building Expansion Joint Mockups: Perform the following tests in the following order:
1. Water Penetration under Static Pressure: ASTM E 1105 with minimum uniform static-air-pressure differential specified for laboratory testing, but not less than 6.24 lbf/sq. ft. (300 Pa).
 - a. No evidence of water penetration.
 2. Water-Spray Test: AAMA 501.2.
 - a. No evidence of water penetration.
- 3.5 BUILDING ENCLOSURE TESTING
- A. Building Enclosure Testing: Perform testing before installation of interior finishes unless otherwise indicated.
 - B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - C. Building Enclosure Testing: Perform the following tests in the following order:

1. Smoke Testing: ASTM E 1186 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
2. Opaque Wall Air Infiltration: ASTM E 783 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Maximum air leakage of 0.25 cfm/sq. ft.
3. Window Air Infiltration: ASTM E 783 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75 Pa).
 - a. Maximum air leakage of 0.3 cfm/sq. ft.
 - b. Perform a minimum of two tests.
4. Water Penetration under Static Pressure: ASTM E 1105 with minimum uniform static-air-pressure differential of 8.0 lbf/sq. ft. (384 Pa).
 - a. No evidence of water penetration.
5. Water Penetration under Dynamic Pressure: AAMA 501.1 at a minimum air-pressure differential of 8.0 lbf/sq. ft. (384 Pa).
 - a. No evidence of water penetration.
6. Water-Spray Test: AAMA 501.2.
 - a. No evidence of water penetration.
7. Flood Testing of Horizontal Waterproofing: ASTM D 5957 on all exterior horizontal surfaces.
 - a. No evidence of water penetration.
8. Location of Wet Insulation in Roofing Systems: ASTM C 1153.
9. Pull-off Strength of Adhered Air Barriers: ASTM D 4541 as modified by ABAA.
 - a. Minimum 16 lbf/sq. in. (110 kPa) adhesion to substrate.
10. Anchor Pull-Out: ASTM E 488/488M.
11. Pull Test for EIFS: ASTM E 2359.
 - a. Refer to drawings for design pressures applicable.
12. Sealant Durability: ASTM C 794.
 - a. 15 lb./in minimum.
 - b. Perform a minimum of three tests.
13. Whole Building Air Leakage Rate by Fan Pressurization: ASTM E 779.
 - a. Maximum Air Leakage Rate: 0.3 cfm/sq. ft.
14. Whole Building Air Tightness Using an Orifice Blower Door: ASTM E 1827.
 - a. Maximum Air Leakage Rate: 0.3 cfm/sq. ft.

END OF SECTION 019113

SECTION 02 4113 - SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.01 SUBMITTALS

Not Applicable

1.02 PROJECT CONDITIONS

- A. Conduct demolition operations without interference with vehicle and pedestrian traffic in adjacent areas.
- B. Protect portions of existing structures, utilities and benchmarks indicated to remain. Promptly repair or replace, as approved by Owner, damage to property, structural elements, utilities, systems or related work indicated to remain and damaged by this work.
- C. Be responsible for methods and sequences of demolition work so that work progresses in safe manner and without affecting structural integrity of adjacent or interconnected work. Stop work and notify Owner for instructions should conditions become evident affecting structural integrity or unsafe conditions.
- D. Provide barriers and warning devices to protect personnel in regions adjacent to demolition areas.
- E. The use of explosives and fire shall not be permitted in demolition work without prior approval of Owner and local officials.
- F. Remove any hazardous products encountered and dispose of these products in accordance with all Local, State, and Federal Laws.

1.03 QUALITY ASSURANCE

Not Applicable

1.04 WARRANTY

Not Applicable

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 SITE DEMOLITION

- A. Remove indicated existing above and below grade structures to full depth encountered.

- B. Abandoned utilities and utilities to be removed shall be disconnected and sealed off at source prior to beginning related demolition work.

END OF SECTION 02 4113

SECTION 024119 - SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Demolition and removal of hazardous materials.
 - a. Lead based paint.
 - b. Hazardous building materials.
 - 3. Salvage of existing items to be reused or recycled.

1.2 SUBMITTALS

- A. Qualification Data: For demolition firm and professional engineer.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Locations of proposed dust- and noise-control temporary partitions and means of egress.
 - 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 - 7. Means of protection for items to remain and items in path of waste removal from building.
- C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
- D. Pre-demolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations.
- E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.3 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 and NFPA 241.

- D. Pre-demolition Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to selective demolition including, but not limited to, the following:
1. Inspect and discuss condition of construction to be selectively demolished.
 2. Inspect and discuss hazardous materials to be removed.
 3. Review structural load limitations of existing structure.
 4. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 5. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 6. Review areas where existing construction is to remain and requires protection.

1.4 PROJECT CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
1. Before selective demolition, Owner will remove the following items:
 - a.
- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- C. Hazardous Materials: Hazardous materials are present in construction to be selectively demolished. A report on the presence of hazardous materials is attached as Appendix A of this document for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations.

1.5 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

END OF SECTION 024119

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SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.2 RELATED SECTIONS

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - Cast-in-Place Concrete.

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 117-10 Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301-10 Specifications for Structural Concrete.
 - 3. ACI 347-04 Guide to Formwork for Concrete.
- B. American Forest and Paper Association (AF&PA):
 - 1. ANSI/AWC NDS-2015 "ASD/LRFD National Design Specification for Wood Construction," 2015 Edition.
 - 2. "2015 NDS Supplement: Design Values for Wood Construction."
 - 3. ANSI/AWC SDPWS-2005 "2005 Special Design Provisions for Wind and Seismic (SDPWS)."
- C. American Plywood Association (APA):
 - 1. APA PDS-04 Panel Design Specification
 - 2. APA Design/Construction Guide, Concrete Forming, Form No. V345, December 2003.

1.4 CONTRACTOR RESPONSIBILITY

- A. Formwork design and engineering.
- B. Construction of formwork, shoring, removal of forms, and reshoring.
- C. Providing a safe structure at all times and ensuring safety to human life and property.

1.5 DESIGN REQUIREMENTS:

- A. General: In accordance with the references.
- B. Design:
 - 1. Design formwork to withstand applicable hydrostatic pressure of concrete plus dead weight, construction loads and vibrations.
 - 2. Limit deflection of studs and walers to 1/400 of the span for architectural concrete and 1/360 of the span for other concrete. Limit deflection of form facing material

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3. exposed to view to 1/240 of the span.
Build adequate supports into forms for:
- a. load concentrations
 - b. external vibrations

1.6 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Shop Drawings:
 - 1. Show:
 - a. Use the structural member designation system used on the Contract Drawings.
 - b. Joint locations and details.
 - c. Size and locations of sleeves, blockouts, and slab penetrations.
 - d. Shoring and support layout.
 - 2. Indicate:
 - a. Form materials, types, and thickness.
 - b. Form tying system and layout.
 - c. Form accessories.
 - d. Details to be used at sleeves, blockouts, and slab penetrations.
 - e. Type and capacity of shores and supports.
 - f. All shop drawings to be signed, dated and sealed by the formwork designer.
- C. Product Data: Manufacturer's product specifications and installation instructions for manufactured products, including form sealer and release agent.
- D. Concrete Strength Tests: Testing Agency's reports for testing required in this Section.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301, ACI 347 and APA V345.
- B. Maintain one copy of ACI 301, ACI 347 and APA V345 on site.

1.8 QUALIFICATIONS

- A. Form Work Designer: Design formwork under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Georgia.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ACI 301 for design, fabrication, erection and removal of formwork.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle formwork materials and accessories at the site to prevent any damage.
- B. Store formwork materials and accessories off ground in ventilated and protected manner to prevent deterioration from moisture.

1.11 COORDINATION

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- A. Coordinate this Section with other Sections of work, which require attachment of components to formwork.
- B. If formwork placed after reinforcement results in concrete cover over reinforcement that is insufficient, request instructions from Architect/Engineer before proceeding.

PART 2 - PRODUCTS

2.1 WOOD FORM MATERIALS

- A. Plywood: APA B-B Plyform Class I, Exterior Grade, mill oiled and edge sealed.
- B. Lumber: Southern Pine species; Select Structural # 2 Grade or better with grade stamp clearly visible, and conforming to NDS design values for visually graded lumber.

2.2 PREFABRICATED FORMS

- A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- B. Pan Forms:
 - 1. Provide forms complete with end enclosures to provide a true, clean, and smooth concrete surface.
 - 2. Design unit for easy removal without damaging placed concrete.
 - 3. Factory fabricate units of either of the following:
 - a. Steel: 16 gage, free of dents, irregularities, sag, and rust.
 - b. Glass-Fiber Reinforced Plastic: Molded under pressure with matched dies, 0.11-inch minimum wall thickness.

2.3 FORMWORK ACCESSORIES

- A. Form Ties: Removable or Snap-off type, metal, fixed length, plastic cone type, free of defects that could leave holes larger than one inch in concrete surface. Provide ties so that the portion remaining within the concrete after removal of the exterior part is at least 1 1/2 inches from the outer concrete surface.
- B. Form Release Agent: Colorless mineral oil, which will not stain concrete, or absorb moisture.
- C. Corners: Chamfered using wooden strip.
- D. Dovetail Anchor Slot: Galvanized steel, 22 gage thick, foam filled release tape sealed slots, and anchors for securing to concrete formwork.
- E. Flashing Reglets: Galvanized steel 22 gage, longest possible lengths, with alignment splines for joints, foam filled release tape sealed slots, and anchors for securing to concrete formwork.
- F. Nails, Spikes, Lag Bolts, Through Bolts, and Anchorages: Sized as required, of strength and character to maintain formwork in place while placing concrete.
- G. Waterstop:
 - 1. Paul Murphy Plastics Co., ribbed, center bulb, 6 inch.

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2. Colloid Environmental Technologies Company (CETCO), Waterstop RX, butyl rubber bentonite compound rope, 25% butyl rubber/75% sodium bentonite composition.
 3. Synko - Flex Products Inc., Synko-Flex, preformed plastic waterstop.
 4. Substitution: Under provisions of Section 01 25 13 Product Substitution Procedures.
- H. Inserts:
1. Adjustable Wedge Inserts:
 - a. Malleable cast iron.
 - b. Complete with bolts, nuts, and washers.
 - c. 3/4 inch diameter bolt unless noted otherwise.
 2. Threaded Inserts:
 - a. Malleable cast iron.
 - b. Complete with full depth bolts.
 - c. 3/4 inch diameter bolt unless noted otherwise.
 3. Ceiling and Soffit Inserts: Used for suspended ceilings and soffits.
 - a. 14 Ga. galvanized steel.
 - b. Nailer type.
- I. Sealer for plywood: Colored polyurethane coating of type acceptable to plywood manufacturer, for sealing cut edges of plywood.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Reinforcing steel bars, wire fabric and accessories for cast-in-place concrete.

1.2 RELATED SECTIONS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 301-14 Specifications for Structural Concrete.
 - 2. ACI 318-14 Building Code Requirements for Structural Concrete.
 - 3. ACI SP-66 (04) Detailing Manual.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A108-07 Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
 - 2. ASTM A615-09b Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 3. ASTM A706-09b Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 4. ASTM A1064-10e1 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
 - 5. ASTM C1116-10a(2015) Standard Specification for Fiber-Reinforced Concrete.
 - 6. ASTM D1751-04(2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bitumenous Types).
- C. American Welding Society (AWS):
 - 1. AWS D1.1-10 Structural Welding Code - Steel.
 - 2. AWS D1.4-98 Structural Welding Code - Reinforcing Steel.
- D. Concrete Reinforcing Steel Institute (CRSI):
 - 1. CRSI- Manual of Standard Practice, 28th Edition, 2009.
 - 2. CRSI - Placing Reinforcing Bars, 8th Edition, 2005.
 - 3. CRSI – Reinforcing Bars: Anchorages and Splices, 5th Edition.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Shop Drawings:
 - 1. Indicate bar sizes, spacing, locations, and quantities of reinforcing steel and wire fabric.

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2. Bending and cutting schedules.
 3. Supporting and spacing devices.
 4. Use the same designation numbers for slabs, beams, columns, and footings as used on the Drawings.
 5. Detail beams and walls in elevation.
 6. Do not make shop drawings using reproductions of or making reference to Contract Drawings.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Submit manufacturer's data and installation instructions for:
1. Mechanical splice device.
 2. Headed concrete anchor.
 3. Deformed bar anchor.
- E. Welder's qualification certificates.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with CRSI Manual of Practice ACI 301 and ACI SP-66.
- B. Submit certified copies of mill test report of reinforcement materials analysis.
- C. Employ welders on the Work that have successfully qualified for the welding positions required in accordance with Chapter 6, Qualification, AWS D1.4 within the last 12 months. Welders are required to carry proof of their qualification on their person.

1.6 COORDINATION

- A. Coordinate with placement of formwork, formed openings and other Work.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615, 60-ksi yield grade; deformed billet steel bars.
- B. Weldable Reinforcing Steel: ASTM A706, 60 ksi yield grade; deformed low-alloy steel bars.
- C. Welded Steel Wire Fabric: ASTM A1064 Plain Type; flat sheets.
- D. Fiber Reinforcement:
1. Fiber length: 2.25 inch maximum.
 2. Use one of the following:
 - a. Grace Construction Products, Strux 90/40
 - b. Fibermesh Inc., Fibermesh 650
 - c. Forta Corporation, Forta Ferro.
 - d. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
- E. Headed Concrete Anchors:

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1. Flux filled.
 2. Made from cold drawn steel in accordance with ASTM A108, grades C-1010 through C-1020, yield strength, 50 ksi.
- F. Deformed Bar Anchors:
1. Flux filled.
 2. Made from cold drawn steel in accordance with ASTM A108, yield strength, 70 ksi.
 3. Deformed in accordance with ASTM A496.

2.2 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16 gage annealed type.
- B. Bar Support: Includes spacers, chairs, bolsters, ties and other devices for spacing, supporting and fastening reinforcement in place.
1. General: In accordance with CRSI Manual of Standard Practice.
 2. Factory made.
 3. Use bar support heights that produce the concrete cover called for on the Drawings.
 4. Use bar supports capable of supporting construction loads without permanent deflection.
 5. Spacing: At 4 feet maximum with first support 2 feet from end of bar supported.
 6. Exposed Concrete: Provide supports in contact with formwork that are:
 - a. High density all plastic (CRSI Class 1).
 - b. Stainless steel protected (CRSI Class 2).
 7. Typical support types and minimum configurations.
 - a. Joist chairs: 3 leg, 3-position type, 6-ga. wire.
 - b. Beam and slab bolsters: continuous, type 7-ga. wire or cementitious fiber reinforced.
 - c. Individual high chairs:
 - 1) Legs 5 inch and under: 2-ga. wire, or high density all plastic.
 - 2) Legs 5 to 12 inches: 0-ga. wire.
 - 3) Do not use individual high chairs with legs over 12 inches.
 - d. Vertical reinforcement: wheel type, high density all plastic.
 - e. Supports bearing on earth.
 - 1) Precast concrete blocks.
 - 2) Support specifically designed for this purpose, e.g. with sand plates.

- C. Mechanical Splices: Install in strict accordance to manufacturer's recommendations.
1. Coupler Splice Devices: Use one of the following complying with requirements of ACI 318, Section 12.14.3.4. Submit for approval.
 - a. Erico Products, Inc., Cadweld.
 - b. Erico Products, Inc., Lenton taper threaded connector.
 - c. Splice Sleeve Japan, Ltd., NMB Splice Sleeve.
 - d. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

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2. End Bearing Compression Only Splice Device: Use one of the following complying with requirements of ACI 318, Section 12.16.4. Submit for approval.
 - a. Erico Products Inc., Speed Sleeve.
 - b. Gateway Erectors Inc., G-Loc.
 - c. Stricon Products Ltd., Pre-Set.
 - d. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

- D. Slab-On-Grade Expansion Joint Filler: Non-extruded bituminous type conforming to ASTM D1751.

- E. Slab-On-Grade Construction Joint: Minimum 24 ga. galvanized steel with formed tongue and groove keyed joint, full depth of slab. Furnish complete with stake pins.

- F. Expansion Anchors:
 1. Install in strict accordance with manufacturer's recommendations.
 2. Only anchors evaluated by an independent research report in accordance with Acceptance Criteria 193 with a published Evaluation Report shall be approved for use. All anchors shall be specifically approved for use in cracked concrete. All anchors shall be approved for resisting seismic and wind loads.
 3. Acceptable manufacturers:
 - a. Hilti Fastening Systems Inc., Hilti Kwik Bolt-TZ, Carbon Steel.
 - b. Powers Fasteners, Atomic+ Undercut Anchors.
 - c. Simpson Strong-Tie Company, Inc., Strong-Bolt 2 Wedge Anchor.
 - d. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

- G. Adhesive Anchors:
 1. Install in strict accordance with manufacturer's recommendations.
 2. Only anchors evaluated by an independent research report in accordance with Acceptance Criteria 308 with a published Evaluation Report shall be approved for use. All anchors shall be specifically approved for use in cracked concrete. All anchors shall be approved for resisting seismic and wind loads.
 3. Acceptable manufacturers:
 - a. Hilti Fastening Systems Inc., HIT-RE 500-SD or HIT-HY 200 Injection Adhesive Anchor.
 - b. Powers Fasteners, PE1000+ Adhesive Anchoring System.
 - c. Simpson Strong-Tie Company, Inc., SET-XP or AT-XP Adhesive System.
 - d. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

- H. Screw Anchors:
 1. Hilti Fastening Systems., KH-EZ Universal Screw Anchor, Carbon Steel.
 2. Powers Fasteners, Wedge-Bolt+.
 3. Simpson Strong-Tie Company, Inc., Titen HD, Carbon Steel.

- I. Slab Shear Reinforcement:

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1. Decon Studrails.
2. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI Manual of Standard Practice.
- B. Locate reinforcing splices where indicated on Drawings.

END OF SECTION

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cast-in-place Concrete.
- B. Floors.
- C. Foundation walls.
- D. Slabs on grade.
- E. Control and expansion joint devices associated with concrete work.
- F. Equipment Pads.

1.2 RELATED SECTIONS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 20 00 - Concrete Reinforcing.

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 117-10 Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301-10 Specification for Structural Concrete for Buildings.
 - 3. ACI 304R-00 Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 4. ACI 305R-10 Hot Weather Concreting.
 - 5. ACI 305.1-06 Specification for Hot Weather Concreting.
 - 6. ACI 306R-10 Cold Weather Concreting.
 - 7. ACI 306.1-02 Standard Specification for Cold Weather Concreting.
 - 8. ACI 318-11 Building Code Requirements for Structural Concrete.
 - 9. ACI SP-15 (10), Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-10 with Selected ACI References.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM C31-10 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33-11a Standard Specification for Concrete Aggregates.
 - 3. ASTM C94-11b Standard Specification for Ready-Mixed Concrete.
 - 4. ASTM C143-10a Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - 5. ASTM C150-09 Standard Specification for Portland Cement.
 - 6. ASTM C171-07 Standard Specification for Sheet Materials for Curing Concrete.
 - 7. ASTM C173-10b Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 8. ASTM C230-08 Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - 9. ASTM C231-10 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - 10. ASTM C260-10a Standard Specification for Air-Entraining Admixtures for Concrete.
 - 11. ASTM C330-09 Standard Specification for Lightweight Aggregates for Structural Concrete.
 - 12. ASTM C494-10 Standard Specification for Chemical Admixtures for Concrete.

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13. ASTM C618-08a Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 14. ASTM C939-10 Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 15. ASTM C1107-11 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 16. ASTM C1240-11a Standard Specification for Silica Fume Used in Cementitious Mixtures.
 17. ASTM D4397-10 Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
 18. ASTM E1155-96(2008) Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.
- A. National Cooperative Highway Research Program (NCHRP)
1. NCHRP Project 20-7 Report #234 Guidelines for Selection of Sealers and Treatments for Bridge Deck Overlays, 2008.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Product Data
1. Mix design for each class of concrete.
 2. Fully document proposed materials and mix designs per ACI 318, Chapter 5.
 3. Submit mix design for review by Testing Agency.
- C. Submit mix design and documentation to Engineer 56 days minimum, prior to use in field.
1. Manufacturer's recommendations for use of admixtures and curing compound.
- D. Quality Control Submittals: Submit two copies plus the number the contractor wants returned.
1. Mill test of Portland cement.
 2. Aggregate tests.
 3. Field cast cylinders. See Field Quality Control.
 4. Floor finish tolerance:
 - a. Report of flatness and levelness test results for each test area.
 - b. Layout of test sections and sample measurement lines with each test area. Provide layout before start of testing operations.
- E. LEED Submittals:
1. Recycled Content, MR Credit 4: For products having recycled content, provide documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
 2. Design Mixtures for MR Credit 4.1: For each concrete mixture containing supplementary cementitious materials such as fly ash, slab cement, or silica fume that have recycled content as a replacement for Portland cement and for equivalent concrete mixtures that do not contain Portland cement replacements, provide 10% to 25% Class F fly ash, 15% to 25% Class C fly ash, or 30% to 60% slag cement by weight of cementitious materials (or combinations).
 3. Location of manufacture and distance from project site for Regional Materials, MR Credit 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery of each raw material.

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Include a statement indicating costs for each regional material and the fraction by weight that is considered regional.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01 32 00 Construction Progress Documentation.
- B. Accurately record actual locations of embedded utilities and components which are concealed from view.

1.6 QUALITY ASSURANCE

- A. Field References: Maintain one copy of each reference listed below in Contractor's field office at all times.
 - 1. SP-15, Field Reference Manual.
- B. Perform Work in accordance with ACI 301.
- C. Acquire cement and aggregate from same source for all work.
- D. Conform to ACI 305R when concreting during hot weather.
- E. Conform to ACI 306R when concreting during cold weather.

1.7 COORDINATION

- A. Coordinate the placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I or III, natural color, domestic manufacture. One brand should be used throughout the project.
- B. Aggregate:
 - 1. Normal Weight
 - a. Fine Aggregate: Quartz sand free of sulfates: ASTM C33.
 - b. Coarse Aggregate: ASTM C33.
- C. Water: clean, potable, and free from deleterious amounts of acids, alkalis, or organic materials.
- D. LEED Requirements:
 - 1. Recycled Content of Concrete Aggregate: Provide products with an average recycled content of not less than 50 percent. Higher recycled content is preferred and should be provided, and documented, if available.
 - 2. Regional Materials: Provide aggregate and accessories that have been manufactured and fabricated within 500 miles of the Project site from materials extracted/recovered and processed within 500 miles of the Project site.

2.2 ADMIXTURES

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- A. General: Do not use calcium chloride or admixtures containing more than 0.1% chloride ions.
- B. Air Entraining: ASTM C260.
- C. Water-Reducing ASTM C494, Type A.
- D. Water-Reducing and Retarding: ASTM C494, Type D.
- E. High Range Water-Reducing (Superplasticizer): ASTM C494, Type F or G.
 - 1. The Euclid Chemical Company:
 - a. Type F: Eucon-37.
 - b. Type G: Eucon-537.
 - 2. Grace Construction Products:
 - a. Type F: Daracem-100.
 - b. Type G: Daracem-100.
 - 3. Master Builders Technologies:
 - a. Type F: Rheobuild 1000.
 - b. Type G: Rheobuild 716.
 - 4. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
- F. Fly Ash: ASTM C618, Type C or F.
 - 1. Use when permitted by Architect.
 - 2. Limit use to not exceed 25% of cementitious materials content by weight.
- G. Silica Fume: ASTM C1240, Provide one of the following:
 - 1. Grace & Co., Force 10,000.
 - 2. Sika Corporation, Sikacrete 950.
 - 3. Master Builders Inc., MB-SF.
 - 4. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
- H. Waterproofing: Crystalline waterproofing admixture, Provide one of the following:
 - 1. Aquafin, Aquafin-IC Admix.
 - 2. Kryton International, Inc, Krystol Internal Membrane (KIM)
 - 3. Xypex Chemical Corp, Xypex Admix C-500.

2.3 ACCESSORIES

- A. Bonding Agent: Polymer resin emulsion, polyvinyl acetate, latex emulsion.
- B. Vapor Retarder: Polyethylene sheeting, 10 mils thick, complying with ASTM D4397.
- C. Curing Materials:
 - 1. Moisture retaining sheet: One of the following, complying with ASTM C171.
 - a. Waterproof paper

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- b. Polyethylene film
- c. Polyethylene-coated burlap
- 2. Liquid membrane forming curing compound:
 - a. Use on a surface to be cured where:
 - 1) A topping material will not be required to bond.
 - 2) A penetrating sealer will not be applied.
 - b. Use one of the following:
 - 1) L & M Chemicals, Inc. Dress & Seal 30.
 - 2) Master Builders, Master Kure
 - 3) Euclid Chemical Co., Super Rez-Seal.
 - 4) Sonneborn Building Products, Kure-n-Seal 30.
 - 5) Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
 - c. To be used where a topping material or penetrating sealer will be required to bond to the surface to which this material is applied. Use the following:
 - 1) Euclid Chemical Company, Kurez DR.
 - 2) Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
- D. Penetrating Sealer: One component silane penetrant for preventing the intrusion of water and water-borne salts. Provide a sealer that exceeds the performance criteria of NCHRP Project 20-7 Report #234. Install in strict accordance with manufacturer's recommendations.

2.4 NON-SHRINK GROUT

- A. Install in strict accordance to manufacturer's recommendations found in each manufacturer's data publication.
- B. Acceptable Manufacturers, one of the following, complying with ASTM C1107:
 - 1. Master Builders, Masterflow 928 Grout
 - a. Application: Fluid installation consistency.
 - 2. Master Builders, Construction Grout
 - a. Application: Stiff or plastic installation consistency.
 - 3. The Euclid Chemical Company, Hi-Flow Grout
 - a. Application: Fluid installation.
 - 4. The Euclid Chemical Company, EUCO N-S Grout
 - a. Application: Stiff or plastic installation consistency.
 - 5. Burke, Non-ferrous, Non-shrink Grout
 - a. Application: Fluid installation consistency.
 - 6. Burke, Damp Pack Grout
 - a. Application: Stiff of plastic installation consistency.
 - 7. Five Star, Non-shrink Grout
 - a. Application: Stiff of plastic installation consistency.
 - 8. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
- C. Installation Consistency Criteria:

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1. Fluid:
 - a. Requires forming for installation.
 - b. To 30 seconds flow by ASTM C939.
2. Plastic or Stiff:
 - a. Does not require forming.
 - b. Plastic: 100% flow by ASTM C230.
 - c. Stiff: 40% flow by ASTM C230.

2.5 CONCRETE MIX

- A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.
- B. Concrete Mix Designs:
 1. Established concrete mix proportions on the basis of field experience or laboratory trial batches as specified in ACI 301 in Section 3.9, "Proportioning on the basis of previous field experience or trial mixtures," with the following exceptions:
 - a. The standard deviation is determined from tests of mixes that:
 - 1) Contain the same materials as mix designs for the proposed work.
 - 2) Represent concrete produced to meet the same design strength as that specified for the proposed work.
 - b. When acceptable field-test records or trial mixture data is not available, and, if approved by the Architect, the concrete mix proportions may be established as specified in ACI 301, Section 3.10, "Proportioning based on empirical data."
 - c. Retain an independent testing laboratory to conduct tests made on trial mixes used in proportioning concrete mixes for the proposed work.
 - 1) Produce trial mixes within 12 months of submission of mix design for approval.
- C. The following classes of concrete are required (Coordinate with Contract Drawings):

Mark	Minimum Compressive Strength	Acceptance Criteria Interval	Slump Range	Max. Water-Cementitious Material Ratio
	f 'c			
	PSI	DAYS	IN	
A	3000	28	5 ± 1	0.55
B	4500	28	5 ± 1	0.40
C	5000	28	5 ± 1	0.40
D	3000	28	5 ± 1	0.55

- D. Air Content:
 1. Provide concrete containing entrained air (between 4% and 6%) and conforming to ACI 301 when concrete will be subject to potentially destructive exposure (other

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- than wear of loading) such as freezing and thawing, severe weathering, or deicing chemicals.
2. Provide concrete containing a maximum air content of 3% when used in interior slabs subject to abrasion.
- E. Use accelerating admixtures in cold weather only when approved by Architect/Engineer. Use of admixtures will not relax cold weather placement requirements.
- G. Use set retarding admixtures during hot weather only when approved by Architect/Engineer.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Section 03 10 00 - Concrete Formwork
- B. Section 03 20 00 - Concrete Reinforcement.
- C. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C33-11a Standard Specification for Concrete Aggregates.
 - 2. ASTM C150-09 Standard Specification for Portland Cement.
 - 3. ASTM C309-11 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Submit Manufacturer's printed instructions for installation of the bonding agent, retarder, and curing compound.

1.4 QUALITY ASSURANCE

- A. Industry Standards:
 - 1. References: Some products and execution are specified in this Section by reference to published specifications or standards of the following (with respective abbreviations used). These referenced publications may be subject to special conditions and/or limitations where specified herein.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I, gray, domestic manufacture. One brand should be used throughout the project.
- B. Fine Aggregate: Fine Aggregate: Quartz sand free of sulfates: ASTM C33.
- C. Water: clean, potable, and free from deleterious amounts of acids, alkalies, organic materials, or chemicals affecting set of cement.

2.2 FINISHING COMPOUNDS

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- A. Bonding Agent:
 - 1. Larsen Products Corporation, Weldcrete.
 - 2. Sika Chemical Corporation, ColmaFix.
 - 3. Sonneborn-DeSoto, Sonocrete.
 - 4. W.R. Grace & Company, Daraweld-C.
 - 5. Euclid Chemical Company, Euco Flex-Con.
 - 6. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

- B. Curing Compound and Sealer: Transparent, resinous sealer in volatile solvent, conforming to ASTM C309.
 - 1. W.R. Grace & Company, Horn Clear Seal 150.
 - 2. Castle Chemical Corporation, Klearseal 'A', V-167.
 - 3. Sonneborn-DeSoto, Kure-N-Seal.
 - 4. Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.

- C. Abrasive Aggregate: Aluminum oxide or emery aggregate graded form particles passing a 1/8" mesh screen and retained on a No. 50 screen.

- D. Clear Wall Coating: Transparent, colorless, non-yellowing, penetrating acrylic sealer,
 - 1. Toch Bros. Division of Carboline Company, Horntraz.
 - 2. Euclid Chemical Company, Euco Rez-Seal.

END OF SECTION

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SECTION 04 05 13
MASONRY MORTARING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Mortar for masonry.

1.2 RELATED SECTIONS

- A. Section 04 05 23 – Masonry Grouting.
- B. Section 04 22 00 – Concrete Unit Masonry.

1.3 REFERENCES

- A. American Society for Testing and Materials, (ASTM).
 - 1. ASTM C91-05 - Standard Specification for Masonry Cement.
 - 2. ASTM C144-11 Standard Specification for Aggregate for Masonry Mortar.
 - 3. ASTM C150-09 Standard Specification for Portland Cement..
 - 4. ASTM C207-06(2011) Standard Specification for Hydrated Lime for Masonry Purposes.
 - 5. ASTM C270-08a Standard Specification for Mortar for Unit Masonry.
 - 6. ASTM C780-11 Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Contractor's responsibilities:
 - 1. Mix Design: Proportion in conformance with ASTM C270. Indicate if the Proportion or Property Method was used, required environmental conditions, and admixture limitations.
 - 2. Submit manufacturer's certificate that products meet or exceed specified requirements.
 - 3. Submit premix mortar manufacturer's installation instructions.
- C. Testing Agency's Responsibilities:
 - 1. Submit test reports on mortar indicating conformance to ASTM C270.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site, except aggregate, in original and unopened container displaying product name, type, grade, and mixing instructions.
- B. Maintain packaged materials clean, dry, and protected against dampness, rain, ground water, freezing, and foreign matter.
- C. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

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1.6 QUALITY ASSURANCE:

- A. Throughout project, provide only one brand of each type and color of cement specified.

1.7 MIX TESTS

- A. Testing of Mortar Mix: In accordance with ASTM C780.
- B. Test Mortar Mix for compressive strength, consistency, water content air content.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I, gray color.
- B. Masonry Cement: ASTM C91, Type S.
- C. Pre-mixed, colored masonry cement:
 - 1. Acceptable products; pending compliance with specified characteristics and acceptable color range to match specified color:
 - a. Citadel Cement, Div. LaFarge Corp., Citadel Custom Color Masonry Cement.
 - b. Coplay Cement Co., Brixment-In-Color.
 - c. Holnam, Inc., Rainbow Motarmix Masonry Cement.
 - d. Lehigh Portland Cement Co., Custom Color Masonry Cement.
 - e. National Cement Co., Coosa Masonry Cement.
 - f. Riverton Corp., Flamingo Masonry Cement.
 - g. U. S. Cement Co., Custom Color Masonry Cement.
 - 2. Characteristics: Meeting ASTM C91, Type S non-staining, 22% maximum air content by volume, with inert, alkali-resistant, fade-resistant mineral pigments and complete with water-reducing and plasticizing admixtures, proportioned to comply with requirements of ASTM C270 for Type S mortar with minimum 28-day compressive strength of 1800 psi.
 - 3. Colors: Custom colors as selected by Architect from samples formulated for Type S mortar.
- D. Mortar Aggregate: ASTM C144, standard masonry type. Clean, hard, natural washed sand. Provide aggregate from single source for colored mortar.
- E. Hydrated Lime: ASTM C207, Type S.
- F. Water: Clean and potable.

2.2 MORTAR MIXES

- A. Mortar: ASTM C270, using the Property Method.
 - 1. Exterior masonry walls below grade: Type M
 - 2. Exterior masonry walls above grade: Type S, 1800 psi minimum.
 - 3. Interior masonry walls: Type N, 750 psi minimum.
- B. Pointing Mortar: One part masonry cement to one part Type S hydrated lime to four parts aggregate.

2.3 MORTAR MIXING

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- A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C270.
- B. Do not use anti-freeze compounds to lower the freezing point of mortar.
- C. If water is lost by evaporation, retemper only within two hours of mixing.
- D. Use mortar within two hours after mixing at temperatures of 80 degrees F or two-and-one-half hours at temperatures under 50 degrees F.

END OF SECTION

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SECTION 04 05 23
MASONRY GROUTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Grout for masonry.

1.2 RELATED SECTIONS

- A. Section 04 05 13 – Masonry Mortaring.
- B. Section 04 22 00 – Concrete Unit Masonry.

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 530/530.1-11 Building Code Requirements and Specification for Masonry Structures and Related Commentaries.
- B. American Society for Testing and Materials, (ASTM).
 - 1. ASTM C91-05 - Standard Specification for Masonry Cement.
 - 2. ASTM C150-09 Standard Specification for Portland Cement.
 - 3. ASTM C207-06(2011) Standard Specification for Hydrated Lime for Masonry Purposes.
 - 4. ASTM C404-11 Standard Specification for Aggregates for Masonry Grout.
 - 5. ASTM C476-10 Standard Specification for Grout for Masonry
 - 6. ASTM C1019-11 Standard Test Method of Sampling and Testing Grout.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Contractor's Responsibilities:
 - 1. Mix Design: Proportion in conformance with ASTM C476. Indicate if the Proportion or Property Method was used, required environmental conditions, and admixture limitations.
 - 2. Submit manufacturer's certificate that products meet or exceed specified requirements.
- C. Testing Agency's Responsibilities:
 - 1. Submit test reports on grout indicating conformance to ASTM C476.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site, except aggregate, in original and unopened container displaying product name, type, grade, and mixing instructions.
- B. Maintain packaged materials clean, dry, and protected against dampness, rain, ground water, freezing, and foreign matter.
- C. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

1.6 QUALITY ASSURANCE:

- A. Throughout project, provide only one brand of each type and color of cement specified.

1.7 MIX TESTS

- A. Testing of Grout Mix: In accordance with ASTM C1019.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I, gray color.
- B. Masonry Cement: ASTM C91, Type S.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Grout Aggregate: ASTM C404.
 - 1. Fine aggregate: Size #1.
 - 2. Coarse aggregate. When minimum horizontal grout space exceeds 4 inches.
 - a. Size #8.
- E. Superplasticizing admixture for cement grout:
 - 1. Acceptable products:
 - a. Anti-Hydro, A-H Super P.
 - b. The Euclid Chemical Co., Melment L10A Super.
 - c. Master Builders, Inc., Rheobuild 1000.
 - d. Sika Corp., Sikament 300.
 - 2. Characteristics: Meeting ASTM C494, Type F; free of chloride ions.
- F. Water: Clean and potable, free from deleterious amounts of alkalis, acids and organic materials.

2.2 GROUT MIXES

- A. Proportion in accord with ASTM C476, except where more stringent requirements are specified herein.
- B. Fine grout: Use for grouting where void to be filled has a minimum dimension of 2" or less. Proportion materials by volume to provide minimum 3000 psi compressive strength at 28 days in accord with ASTM C1019. Provide superplasticizer in all cement grout mixes.
- C. Coarse grout: Use for grouting where void to be filled has a dimension greater than 2". Proportion by volume to provide minimum 3000 psi compressive strength at 28 days in accord with ASTM C1019. Provide superplasticizer in all cement grout mixes.
- D. Bond Beams and Lintels:
 - 1. 2500 psi strength at 28 days
 - 2. 7-8 inches slump
 - 3. Mixed in accordance with ASTM C476 Coarse grout.

- E. Reinforced Masonry:
 - 1. 2500 psi strength at 28 days
 - 2. 7-8 inches slump
 - 3. Mixed in accordance with ASTM C476 Coarse grout.

2.3 GROUT MIXING

- A. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 Coarse grout.
- B. Do not use anti-freeze compounds to lower the freezing point of grout.
- C. Control batching procedure to ensure volume proportions of grout materials and achieve grout slump between 8" and 11".
- D. Measure grout materials mixed at job site by volume and mix ingredients in mechanical mixer for a minimum of five minutes after additions of materials.
- E. Addition of other admixtures, including chloride-based admixtures and antifreeze ingredients, will not be permitted.
- F. Discard grout not placed within 1-1/2 hour after water is added to mix, or sooner if grout begins to set.

END OF SECTION

SECTION 04 2000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Modular face brick
 - 2. Mortar and grout.
 - 3. Reinforcing steel.
 - 4. Masonry joint reinforcement.
 - 5. Ties and anchors.
 - 6. Embedded flashing.
 - 7. Miscellaneous masonry accessories.

PART 2 - PRODUCTS

2.1 BRICK MASONRY (MODULAR FACE BRICK)

- A. Manufacturers:
 - 1. Basis of Design: Cherokee Brick – Georgia Classic Collection
 - 2. Series/Color: TBD
- B. Acceptable manufacturers:
 - 1. Meridian Brick and Masonry Supply
 - 2. Echelon Masonry

2.2 TIES AND ANCHORS

2.2 EMBEDDED FLASHING MATERIALS

2.3 MISCELLANEOUS MASONRY ACCESSORIES

2.4 CAVITY-WALL INSULATION

2.5 MASONRY CLEANERS

2.6 MORTAR AND GROUT MIXES

PART 3 - EXECUTION

END OF SECTION 042000

SECTION 04 22 00

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete masonry units.
- B. Reinforcement, anchorage, and accessories.

1.2 RELATED SECTIONS

- A. Section 04 05 13 – Masonry Mortaring.
- B. Section 04 05 23 – Masonry Grouting.

1.3 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 530/530.1-11 Building Code Requirements and Specification for Masonry Structures and Related Commentaries.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A123-09 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A153-05 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Products.
 - 3. ASTM A615-04a Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
 - 4. ASTM A1064-10e1 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 5. ASTM C90-11b Standard Specification for Loadbearing Concrete Masonry Units.
 - 6. ASTM C140-08a Standard Specification for Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
 - 7. ASTM D1056-07 Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
 - 8. ASTM D2000-08 Classification System for Rubber Products in Automotive Applications.
 - 9. ASTM D2240-05(2010) Test Method for Rubber Property - Durometer Hardness.
- C. Portland Cement Association (PCA):
 - 1. "Concrete Masonry Handbook" Sixth Edition.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Contractor's Responsibilities:
 - 1. Submit product data for masonry units and fabricated wire reinforcement.
 - 2. Cold Weather construction procedures.
 - 3. Hot Weather construction procedures.

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4. Shop Drawings showing:
 - a. Details of steel reinforcement.
 - b. Lintels and door frames.
 - c. Shelf angles.
5. Submit manufacturer's installation instructions under provisions of Section 01 33 00 Submittal Procedures.
6. Submit laboratory results of testing for masonry units.
7. Submit manufacturer's statement attesting to compliance of materials to specification requirements.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not accept damaged masonry units, damaged components of structure, and damaged packaged material.
- B. Protect moisture controlled, concrete masonry units, and cementitious materials from rain and ground water.
- C. Do not use masonry materials that are contaminated.
- D. Protect units to be exposed in finish work from staining and physical damage of exposed faces.
- E. Segregate pallets of various fire-rated units from each other and from other non-rated units; maintain clear indication of rating of stored units for easy identification and selection.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.
- B. Lay no masonry when temperature of surrounding air has dropped below 45 degrees F., unless it is rising, and at no time when it has dropped below 40 degrees F., except with written permission from Architect.
- C. When masonry work is authorized at temperatures below 40 degrees F. but above freezing, provide mortar at temperature between 70 degrees F. and 100 degrees F. Maintain air temperature above 40 degrees F. on both sides of masonry for 72 hours after laying.
- D. Protect masonry construction from direct exposure to wind and sun when erected in ambient air temperatures of 95 degrees F. in the shade with relative humidity less than 50%.
- E. Protection of work:
 1. Keep walls dry during erection by covering at end of each work period with a waterproof membrane. Similarly protect partially completed walls not being worked on. Provide covering that overhangs at least 2'-0" on each side of wall and is anchored on each side of wall.
 2. Protect finished exposed work from stains.

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3. Allow mortar droppings sticking to unit faces to dry and then remove with trowel, lightly scrubbing surface with bristled brush.
 4. Take particular care to keep masonry units clean in areas not to be painted.
- F. Install and inspect mechanical and electrical work prior to enclosing or covering with masonry. Where runs of piping or conduit are required, cut away web of masonry unit without disturbing face or bond.
- G. Coordinate installation of masonry anchors with structural system to which masonry is attached.

PART 2 - PRODUCTS

2.1 CONCRETE MASONRY UNITS

- A. Hollow Load Bearing Block Units: ASTM C90, Grade N; light weight with a compressive strength of masonry (f'm) of 1500 PSI and a net strength of 2000 PSI on the net cross-sectional area of CMU determined in accordance with ASTM C140.

2.2 REINFORCEMENT AND ANCHORAGE

- A. Single Wythe Joint Reinforcement: Ladder type; hot dip galvanized after fabrication cold-drawn steel conforming to ASTM A82, 9 ga. cross ties.
- B. Reinforcing Steel: ASTM A615, 60-ksi yield grade, deformed billet bars.
- C. Strap Anchors: Z bent steel shape, 1 x 12 inch x 3/16 inch thick, galvanized to ASTM A123 G90 finish.
- D. Corrugated Formed Sheet Metal Wall Ties: 7/8 x 6 3/4 inch size 16 gage thick, galvanized steel finish.

2.3 ACCESSORY MATERIALS

- A. Joint Filler: Closed cell neoprene; self adhering, conforming to ASTM D1056, Class RE41, for compression up to 35%.
 1. Vertical joints: 3/8 inch thick.
 2. Horizontal joints below shelf angle: 1/4 inch thick.
- B. Nailing Strips: Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.
- C. Weep Holes: Medium-density polyethylene round plastic tubing, outer diameter equals 3/8 inch (10mm), length equals thickness of masonry assembly.
- D. Cavity Drainage Material: 3/4 inch (19mm) thick, free-draining mesh made from polyethylene strands.
- E. Cavity Vents: Molded polyvinylchloride grilles; insect proof.
- F. Cleaning Solutions: Non-acidic, not harmful to masonry work or adjacent materials.
- G. Rubber Control Joints:
 1. Factory extruded.

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2. Conforms to ASTM D2000, Type 2AA, 805.
 3. Durometer hardness of 80 in accordance with ASTM D2240.
- H. Vertical and Horizontal Bar Positioners:
1. 9 Ga. spider shaped positioner.
 2. Finish: Hot dip galvanize, ASTM A153, Class B-3.
- I. Wire mesh hardware cloth:
1. Galvanize steel mesh, 16 Ga. with 1/2 inch squares.
 2. Width: 2 in less than wall.
 3. Length: 16 inches (minimum).
- J. Structural Steel Anchors:
1. Anchors: 1/4 inch on center, standard bright, wire for welding.
 2. Ties: 3/16 inches on center mill galvanized.
- K. Masonry Screw into Grouted CMU:
1. Install in strict accordance with manufacturer's recommendations.
 2. Acceptable manufacturers:
 - a. Hilti Fastening Systems Inc., KH-EZ Screw Anchor, Carbon Steel.
 - b. ITW Red Head, Tapcon+ Anchor.
 - c. Powers Fasteners, Wedge-Bolt+ Anchor, Carbon Steel.
 - d. Simpson Strong-Tie Company, Inc., Titen HD, Carbon Steel.
 - e. Substitutions: Under provisions of Section 01 60 00 Product Substitution Procedures.
- L. Masonry Screw into Hollow CMU:
3. Install in strict accordance with manufacturer's recommendations.
 4. Acceptable manufacturers:
 - a. ITW Red Head, Tapcon+ Anchor.
 - b. Simpson Strong-Tie Company, Inc., Titen HD, Carbon Steel.
 - c. Substitutions: Under provisions of Section 01 60 00 Product Substitution Procedures.
- M. Masonry Screw into Red Brick:
5. Install in strict accordance with manufacturer's recommendations.
 6. Provide anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) to be in accordance to Acceptance Criteria 106 with a published Evaluation Report.
 7. Acceptable manufacturers:
 - a. Hilti Fastening Systems Inc., Kwik-Con II+, Carbon Steel.
 - b. Powers Fasteners, Wedge-Bolt+ Anchor, Carbon Steel.
 - c. Substitutions: Under provisions of Section 01 60 00 Product Substitution Procedures.
- N. Adhesive Anchor into Hollow or Grouted CMU or Red Brick:
1. Install in strict accordance with manufacturer's recommendations.
 2. Provide anchors evaluated by the ICC Evaluation Service, Inc. (ICC-ES) to be in accordance to Acceptance Criteria 58 with a published Evaluation Report.
 3. Acceptable manufacturers:
 - a. Hilti Corporation, HIT-HY 70 Masonry Adhesive.
 - b. Powers Fasteners, T308+ Adhesive Injection System.
 - c. Simpson Strong-Tie Company, Inc., AT Adhesive System.
 - d. Simpson Strong-Tie Company, Inc., SET Adhesive System.

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- e. Substitutions: Under provisions of Section 01 60 00 Product Substitution Procedures.

- O. Isolation or Joint Stabilization Anchors:
 - 1. Provide an anchor that allows movement at expansion, contraction or isolation joints in masonry while maintaining the wall alignment in a direction normal to the movement.
 - 2. Anchor to consist of two 8 gauge steel wires enclosed in a 1/32 inch thick sheet metal sleeve which is completely separated at the center to allow movement.
 - 3. Include a plastic sleeve on one of the steel wires at the center of the anchor to prevent total closure.
 - 4. Finish to be:
 - a. Mill galvanized for interior walls.
 - b. Stainless steel, grade #304 for exterior walls.

END OF SECTION

SECTION 04 7200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Cast stone masonry.

1.2 DEFINITIONS

- A. Cast Stone: Architectural precast concrete building units intended to simulate natural cut stone.

1.3 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for cast stone units.
- B. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
1. Include building elevations showing layout of units and locations of joints and anchors.
- C. Samples for Initial Selection: For colored mortar.
- D. Samples for Verification:
1. For each color and texture of cast stone required, 10 inches square in size.
 2. For colored mortar. Make Samples using same sand and mortar ingredients to be used on Project.
- E. Mockup Samples: Furnish sample units for each color and texture of cast stone required, 10 inches square in size for installation in mockups.
- F. Full-Size Samples: For each type of cast stone unit required.
1. Make available for Architect's review at Project site.
 2. Make Samples from materials to be used for units used on Project.
 3. Approved Samples may be installed in the Work.
- G. Qualification Data: For manufacturer.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, with sufficient production capacity to manufacture required units.
1. Manufacturer is a producing member of the Cast Stone Institute.
- B. Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

- C. Source Limitations for Cast Stone: Obtain cast stone units through one source from a single manufacturer.
- D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.
 - 1. Build mockup of typical wall area as shown on Drawings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of cast stone with unit masonry work to minimize the need for on-site storage and to avoid delaying the Work.
- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Store installation materials on elevated platforms, under cover, and in a dry location.
- D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.6 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but not less than 7 days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CAST STONE MATERIALS

- A. General: Comply with ASTM C 1364 and the following:
- B. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation as needed to produce required textures and colors as needed to produce required cast stone colors.

- C. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation as needed to produce required textures and colors as needed to produce required cast stone colors.
- D. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, non-fading, and resistant to lime and other alkalis.
- E. Admixtures: Do not use admixtures unless specified or approved in writing by Architect.
 - 1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
 - 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
 - 3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
 - 4. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 5. Water-Reducing, Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 6. Water-Reducing, Accelerating Admixture: ASTM C 494/C 494M, Type E.
- F. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast stone material.
 - 1. Epoxy Coating: ASTM A 775/A 775M.
 - 2. Galvanized Coating: ASTM A 767/A 767M.
- G. Embedded Anchors and Other Inserts: Fabricated from [stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666, Type 304] [steel complying with ASTM A 36/A 36M, and hot-dip galvanized to comply with ASTM A 123/A 123M].

2.2 CAST STONE UNITS

- A. Manufacturers:
- B. Basis of Design: Continental Cast Stone.
 - 1. Texture: TBD
 - 2. Color: TBD
 - 3. Profile: See Drawings
- C. Approved manufacturers:
 - 1. Advanced Cast Stone, Inc.
 - 2. Architectural Cast Stone Corp.
 - 3. Cast Stone Systems, Inc.
- D. Provide cast stone units complying with ASTM C 1364 using the vibrant dry tamp or wet-cast method.
 - 1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666, Procedure A, as modified by ASTM C 1364, or are made from cast stone that has a history of successful resistance to freezing and thawing.

- E. Fabricate units with sharp arris and details accurately reproduced with indicated texture on all exposed surfaces, unless otherwise indicated.
 - 1. Slope exposed horizontal surfaces 1:12, unless otherwise indicated.
 - 2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
 - 3. Provide drips on projecting elements, unless otherwise indicated.
- F. Fabrication Tolerances:
 - 1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
 - 2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
 - 3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
 - 4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.
- G. Cure units by one of the following methods:
 - 1. Cure units with steam in enclosed curing room at temperature of 105 deg F or above and 95 to 100 percent relative humidity for 6 hours.
 - 2. Cure units with dense fog and water spray in enclosed warm curing room at 95 to 100 percent relative humidity for 24 hours.
 - 3. Cure units to comply with one of the following:
 - a. Not less than 5 days at mean daily temperature of 70 deg F or above.
 - b. Not less than 6 days at mean daily temperature of 60 deg F or above.
 - c. Not less than 7 days at mean daily temperature of 50 deg F or above.
 - d. Not less than 8 days at mean daily temperature of 45 deg F or above.
- H. Acid etch units after curing to remove cement film from surfaces to be exposed to view.
- I. Colors and Textures: As selected by Architect from manufacturer's full range.

2.3 MORTAR MATERIALS

- A. Provide mortar materials that comply with Division 04 Section "Unit Masonry."
- B. Portland Cement: ASTM C 150, 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.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
- E. Masonry Cement: ASTM C 91.
 - 1. Products:
 - a. Capital Materials Corporation; Flamingo Color Masonry Cement.
 - b. Essroc, Italcementi Group; Brixment.
 - c. Holcim (US) Inc.; Mortamix Masonry Cement.
 - d. Lafarge North America Inc.; Lafarge Masonry Cement.

- e. Lehigh Cement Company; Lehigh Masonry Cement.
 - f. National Cement Company, Inc.; Coosa Masonry Cement.
- F. Mortar Cement: ASTM C 1329.
- 1. Products:
 - a. Lafarge North America Inc.; Lafarge Mortar Cement.
- G. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
- 1. Products:
 - a. Bayer Corporation, Industrial Chemicals Div.; Bayferrox Iron Oxide Pigments.
 - b. Davis Colors; True Tone Mortar Colors.
 - c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
- H. Aggregate for Mortar: ASTM C 144.
- 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
- I. Water: Potable.

2.4 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from steel complying with ASTM A 36/A 36M, and hot-dip galvanized to comply with ASTM A 123/A 123M.
- B. Dowels: Round stainless-steel bars complying with ASTM A 276, Type 304, and 1/2-inch diameter.
- C. Dowels: Round steel bars complying with ASTM A 36/A 36M or ASTM A 615/A 615M, 1/2-inch diameter, and hot-dip galvanized to comply with ASTM A 123/A 123M.
- D. Proprietary Acidic Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.
 - 1. Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.5 MORTAR MIXES

- A. Comply with requirements in Division 04 Section "Unit Masonry" for mortar mixes.
- B. 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.
 2. Limit cementitious materials in mortar to mortar cement, and lime.
- C. Comply with ASTM C 270, Proportion Specification.
1. For setting mortar, use Type N.
 2. For pointing mortar, use Type N.

2.7 WATER REPELLENT

- A. Siloxane, Penetrating Water Repellent: Clear, oligomeric alkylalkoxysiloxanes containing 10 percent or more solids; with alcohol, ethanol, mineral spirits, water, or other proprietary solvent carrier; and with 3.3 lb/gal. or less of VOCs.
- 1 Products:
- a. Chemical Products Industries, Inc.; CP-500W.
 - b. ChemMasters; Spall Guard WB 10%.
 - c. Chemprobe Coating Systems, L. P.; Prime A Pell H₂O.
 - d. Diedrich Technologies, Inc.; 303-S.
 - e. Euclid Chemical Company (The); Weatherguard.
 - f. Hydrozo, a division of ChemRex; Enviroseal 40.
 - g. ProSoCo, Inc.; Siloxane WB Concentrate].
 - h. SaverSystems, Div. of Meredith, Inc.; Masonry Saver WB.

2.8 SOURCE QUALITY CONTROL

- D. Employ an independent testing agency to sample and test cast stone units according to ASTM C 1364.
1. Include one test for resistance to freezing and thawing.

PART 3 - EXECUTION

END OF SECTION 047200

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SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Structural Steel Framing Members
- B. Baseplates
- C. Grouting Under Baseplates

1.2 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications: Non-framing fabrications affecting structural steel work.

1.3 REFERENCES

- A. American Institute of Steel Construction (AISC):
 - 1. Steel Construction Manual, 15th Edition.
 - 2. Specification for Structural Joints Using High Strength Bolts, Approved by the Research Council for Structural Connections of the Engineering Foundation, December 31, 2009 and endorsed by the AISC.
 - 3. AISC 303-10 Code of Standard Practice for Steel Buildings and Bridges, April 14, 2010.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36-08 Standard Specification for Structural Steel.
 - 2. ASTM A53-10 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
 - 3. ASTM A123-09 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM A307-12 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners.
 - 5. ASTM A500-03a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
 - 6. ASTM A563-07a Standard Specification for Carbon and Alloy Steel Nuts.
 - 7. ASTM A572-12 Standard Specification for High-Strength Low-Alloy Columbium - Vanadium Structural Steel.
 - 8. ASTM A992-11 Standard Specification for Structural Steel Shapes.
 - 9. ASTM F436-11 Standard Specification for Hardened Steel Washers.
 - 10. ASTM F959-09 Standard Specification for Compressible - Washer - Type Direct Tension Indicator for Use with Structural Fasteners.
 - 11. ASTM F1554-07ae1 Standard Specification for Anchor Bolts, Steel, 36, 55 and 105 KSI Yield Strength.
 - 12. ASTM F3125-15a Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
- C. American Welding Society (AWS):
 - 1. AWS D1.1-10 Structural Welding Code - Steel.

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- D. Steel Structures Painting Council (SSPC):
 - 1. SSPC Painting Manual Volume 2, Systems and Specifications, 2011 Edition.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, and locations of structural members and openings.
 - 2. Connections.
 - 3. Cambers.
 - 4. Indicate welds by standard AWS symbols. Show size, length and type of each weld.
 - 5. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages.
 - 6. Do not make shop drawings using reproductions of or making reference to Contract Drawings.
- C. Calculations:
 - 1. Provide calculations, sealed by a Professional Engineer registered in the State of Georgia that indicate compliance with design criteria.
 - a. Perform calculations, analysis and computation of all elements associated with connection design for structural steel framing, except where fully detailed on the Contract Documents.
 - b. Include:
 - 1) Description of design criteria.
 - 2) Referenced piece marks or location in the building.
 - 3) Engineering analysis depicting acceptable connection element stresses and all applicable limit states.
 - c. The connection designer shall immediately notify the Engineer in writing of any connections for which incomplete or unclear information is indicated on the Contract Drawings. These include all shear connections and all moment connections not specifically detailed on the Drawings.
- D. Manufacturer's Mill Certificate: Submit certifying that products meet or exceed specified requirements.
- E. Mill Test Reports: Submit Manufacturer's Certificates, indicating structural strength, destructive and non-destructive test analysis.
- F. Submit Manufacturer's Product Data indicating products meet all specified requirements, and submit complete installation instructions for:
 - 1. Load indicator washers
 - 2. Alternate design high strength bolts.
- G. Welders' Certificates: Submit welders' certificates for each welder to be employed on this project. Certificates to indicate welder has been tested on type of weld in last 12 months.
- H. Field Quality Control Reports: Submit reports of specified tests and inspections.

1.5 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC - Steel Construction Manual, 15th Edition.

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1.6 QUALIFICATIONS

- A. Fabricator: Certified by AISC Quality Certification Program under "Certification Standard for Steel Building Structures (BU)."
- A. Erector: Company specializing in performing the work of this Section with minimum 10 years documented experience.
- B. Connection Designer: Design connections not detailed on the Contract Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Georgia.
- C. Welder: Employ welders on the Work that have successfully qualified for the welding positions required in accordance with Chapter 5 "Qualification," AWS D1.1 Qualification, within the last 12 months. Welders are required to carry proof of their qualification on their person.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Steel Shapes
 - 1. W-Shapes: ASTM A992, Grade 50.
 - 2. M-Shapes: ASTM A36.
 - 3. S-Shapes: ASTM A36.
 - 4. HP-Shapes: ASTM A36.
 - 5. Channels: ASTM A36.
 - 6. Angles: ASTM A36.
 - 7. Structural Tees: ASTM A992, Grade 50.
- B. Structural Steel Plates and Bars: ASTM A36.
- C. Cold Formed Steel Tubing: ASTM A500, Grade B.
- D. Hot Formed Steel Tubing: ASTM A501. Type E or S, Grade B.
- E. Pipe: ASTM A53 Type E or S, Grade B.
- F. High Strength Bolts: All material, domestic manufacture, marked with lot identification.
 - 1. High strength bolts:
 - a. Standard bolts: ASTM F3125 Grade A325 or Grade A490, type I.
 - b. Alternate design bolts: Conforming to ASTM F3125.
 - 1) NSS Industries, Rapid Tension Bolts.
 - 2) Le Jeune Bolt Company, Tension Control Bolts.
 - 3) Bethlehem Steel Corporation, Load Indicator Bolt.
 - 4) Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
 - 2. Nuts: ASTM A563.
 - 3. Washers:
 - a. Hardened steel washers: ASTM F436.
 - b. Direct tension indicator washer (Load Indicator Washer): ASTM F959.
- G. Anchor Rods: ASTM F1554, Grade 36.

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- H. Electrodes for welding in accordance with AWS D1.1.
- I. Sliding Bearing Plates: Tetraflouroethylene (TFE) reinforced with glass fibers and applied to stainless or structural steel plates.
- J. Shop Paint and Touch-Up Primer
 - 1. Shop paint for interior steel:
 - a. Type: Modified soya oil alkyd resin - lead and chromate free.
 - b. Solids Content: 55%
 - 2. Shop paint for exterior steel:
 - a. Vehicle type: Inorganic Ethyl Silicate (self-curing).
 - b. Pigment type: Zinc dust plus colorant (green).
 - c. Pigment content: 85% Zinc dry film by weight.
 - d. Solids content: 79% by weight, 71% by volume packing density ratio of wet to dry film.
- K. Non-Shrink Grout: See Section 03 30 00 Cast-In-Place Concrete.

2.2 **FABRICATION**

- A. General: In accordance with the References.
- B. Fabricate and assemble structural assemblies in shop to greatest extent possible and deliver to the site ready for erection.
- C. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs and other defects. Do not weld or grind a member once finishing is complete.
- D. Connections:
 - 1. Shop connections: Welded or as otherwise indicated on the Contract Drawings.
 - 2. Field connections: Bolted except where shown as welded on the Contract Drawings.
 - a. Provide ASTM F3125 Grade A325 bolts unless noted otherwise.
 - b. Minimum bolt diameter is 3/4 inches.
 - c. Provide a minimum of two bolts at each connection.
 - 3. When not specifically detailed on the Contract Drawings, provide the following beam connections.
 - a. Where beam reactions are given, provide the capacity shown.
 - b. Where beam reactions are not given, design connections to support one half of the total uniform load capacity shown in the AISC - Steel Construction Manual, 15th Edition.
 - c. Where reactions are subject to eccentricity, such eccentricity shall be taken into account.
 - 4. Shop attach column base plates to columns unless noted otherwise on the Contract Drawings.

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- E. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, ONLY as shown on the Contract Drawings.
- F. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
- G. Shop painting: Prime all steel surfaces not otherwise specified. Use paint complying with all Federal, State and Local VOC requirements where it is applied.
 - 1. Surfaces to be primed:
 - a. Interior steel:
 - 1) Surface preparation: Hand tool cleaning (SSPC-SP2).
 - 2) Apply one coat of interior steel shop coating.
 - 3) Dry film thickness: 2 to 3 mils.
 - b. Exterior steel:
 - 1) Surface preparation: Commercial blast cleaning (SSPC-SP6).
 - 2) Apply one coat of exterior steel shop coating.
 - 3) Dry film thickness: 3 mils (85% Zinc, dry film by weight).
 - c. Work shop paint into all angles and crevices.
 - d. Apply shop paint uniformly and free from holidays and bare spots.
 - 2. Surfaces to be encased in concrete:
 - a. Surface preparation: Power tool cleaning (SSPC-SP3).
 - b. Prime surfaces to be exposed as described in the shop painting paragraph of this Section.
 - 3. Surfaces to be fireproofed:
 - a. Surface preparation: Commercial blast cleaning (SSPC-SP6).
 - b. Ship to job site unprimed.
 - 4. Do not paint:
 - a. Surfaces to receive weld metal.
 - b. Faying surfaces of high strength bolted connections.
 - c. Tops of flanges of floor beams scheduled to receive shear studs.
 - d. Steel enclosed in Gyp board walls or columns

2.3 SOURCE QUALITY CONTROL AND TESTS

- A. Testing Laboratory perform the following:
 - 1. Inspection of shop assembled high strength bolts under provision of Field Quality Control of this Section.
 - 2. Inspection of shop welds under the provisions of Field Quality Control of this Section.

END OF SECTION

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SECTION 05 21 00
STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Open web steel joists, with bridging, attached seats, and anchors.
- B. Joist Girders.
- C. Loose bearing plates and anchor bolts for site placement.

1.2 RELATED SECTIONS

- A. Section 05 12 00 - Structural Steel Framing.
- B. Section 05 31 13 - Steel Floor Decking: Support framing for small openings in roof deck.
- C. Section 05 31 23 - Steel Roof Decking: Support framing for small openings in roof deck.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36-08 Standard Specification for Carbon Structural Steel.
 - 2. ASTM A307-12 Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- B. American Welding Society (AWS):
 - 1. AWS D1.1-10 Structural Welding Code - Steel.
- C. Steel Joist Institute (SJI)
 - 1. Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders, 44th edition.
- D. Steel Structures Painting Council (SSPC)
 - 1. SSPC Painting Manual Volume 2, Systems and Specifications, 2011 Edition.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Shop Drawings: Include the following:
 - 1. Indicate standard designations, configurations, and sizes.
 - 2. Location and spacing of joists by identification marks.
 - 3. Details of end anchorages including minimum bearing requirements.
 - 4. Details of joist extensions, bottom chord anchorages including locations of connections.
 - 5. Spacing and type of bridging.
 - 6. Detail welds using AWS symbols.
 - 7. Details of bridging connections to joists and to structure where lines of bridging terminate.
 - 8. Details and locations of accessories for uplift.
 - 9. Details of splices.
 - 10. Do not make Shop Drawings using reproduction of or reference to Contract Drawings.

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- C. Welders' Certificates: Submit welders' certificates for each welder to be employed on this project. Certificates to indicate welder has been tested on type of weld in last 12 months.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with SJI Standard Specifications and Load and Weight Tables for Steel Joists and Joist Girders, including headers and other supplementary framing.

1.6 QUALIFICATIONS

- A. Manufacturer: Member of Steel Joist Institute.
- B. Fabricator: Member of Steel Joist Institute.
- C. Erector: Company specializing in performing the work of this Section with minimum 3 years documented experience.
- D. Connection Designer: Design connections not detailed on the Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of Georgia.
- E. Welder: Employ welders on the Work that have successfully qualified for the welding positions required, in accordance with Chapter 5 "Qualification," AWS D1.1 Qualification, within the last 12 months. Welders are required to carry proof of qualification on their person.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of SJI requirements.
- B. Store and protect products under provisions of SJI requirements.
- C. Protect joists from distortion or damage.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as shown on Shop Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Open Web Joists Members: SJI Type K open web.
- B. Bolts, Nuts, and Washers: ASTM A307.
- C. Primer: SSPC - Paint 15, Type 1.
- D. Structural Steel for Supplementary Framing and Joist Leg Extensions: ASTM A36.
- E. Welding Materials: AWS D1.1; type required for materials being welded.

2.2 FABRICATION

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- A. Provide bottom and top chord extensions as indicated. Provide load carrying capacity equal to or greater than loads shown on the Drawings for area being supported.
- B. Bridging:
 - 1. Provide horizontal or diagonal type bridging. Where horizontal bridging is used, provide a vertical "x" brace in the second interior panel and in every sixth panel.
 - 2. Provide bridging anchors for ends of bridging lines terminating.
- C. End Anchorage: Provide end anchorages to attach joists to adjacent construction.
 - 1. Sloped end bearing: Provide beveled or sloped bearing connections where joists are sloped, except where slope is equal to or less than 1/4 inch per foot.
 - 2. Special end bearing: Provide special end supports at shelved end bearings and at those locations where joist bearing area is less than minimum recommended by SJI specifications.
- D. Header Units: Provide header units to support joist tails at roof openings not framed with steel shapes.
- E. Bolts: Provide erection and permanent bolts.

2.3 FINISH

- A. Shop prime joists. Do not prime surfaces that will be fireproofed or field welded.
- B. Surface preparation: SSPC - SP2.
- C. Application: Apply paint in one coat with continuous dry film thickness of not less than 1 mil.

END OF SECTION

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SECTION 05 31 13

STEEL FLOOR DECKING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel floor deck and accessories.
- B. Formed steel deck end forms to contain wet concrete.
- C. Framing for openings up to and including 18 inches.

1.2 RELATED SECTIONS

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - Cast-in-Place Concrete: Concrete framed openings larger than 18 inches.
- C. Section 05 12 00 - Structural Steel Framing: Structural framed openings larger than 18 inches.

1.3 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S100-07/SC-10 – North American Specification for the Design of Cold-Formed Steel Structural Members, with Supplement 2 dated 2010.
 - 2. AISI S200-07 - North American Standard for Cold-Formed Steel Framing - General Provision.
 - 3. AISI S201-07 - North American Standard for Cold-Formed Steel Framing - Product Data.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36-08 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A653-11 - Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
 - 3. ASTM A924-10a – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 4. ASTM A1008-08a - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- C. American Welding Society (AWS):
 - 1. AWS D1.1-10, Structural Welding Code -- Steel.
 - 2. AWS D1.3-98, Structural Welding Code - Sheet Steel.
- D. DOD/ Military Specifications (MIL):
 - 1. DOD-P-21035 A/MIL-P-21035A Paint High Zinc Dust Content, Galvanizing Repair, 2003.
- E. Steel Deck Institute (SDI):
 - 1. SDI Code of Standard Practice - No. COSP, May 2012.
 - 2. Design Manual for Composite Decks, Form Decks, and Roof Decks – No. 31.
 - 3. Diaphragm Design Manual, Third Edition – No. DDM03 September 2004.

1.4 SUBMITTALS

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- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Shop Drawings: Indicate
 - 1. Decking plan and erection sequence
 - 2. Support locations, projections
 - 3. Openings and reinforcement
 - 4. End lap and side lap details
 - 5. Pertinent details, and accessories, including type, size and spacing of fasteners
 - 6. Fastener pattern including type, size and spacing of fastener
 - 7. Temporary shoring of decking where required.
 - 8. Do not make shop drawings using reproductions of or making reference to Contract Drawings.
- B. Product Data: Provide manufacturer's specifications and installation instructions for each type of deck and accessory. Provide deck profile characteristics and dimensions, structural properties, and finishes.
- C. Manufacturer's Installation Instructions: Indicate specific installation sequence and special instructions.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum 3 years documented experience.
- B. Manufacturer: Member of Steel Deck Institute.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01 65 00 Product Delivery
- B. Store and protect products under provisions of Section 01 66 00 Product Storage and Handling Requirements
- C. Cut plastic wrap to encourage ventilation.
- D. Store decking on dry wood sleepers; slope for positive drainage.

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as shown on shop drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Sheet Steel: ASTM A653, Grade 33 Structural Quality; with G90 galvanized coating designation conforming to ASTM A924.
- B. Paint: Manufacturer's baked on, rust inhibitive paint, for application to metal surfaces that have been chemically cleaned and phosphate chemical treated.

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- C. Bearing Plates: ASTM A36 steel, unfinished.
- D. Welding Materials: AWS D1.1.
- E. Touch-Up Primer: Zinc chromate type.

2.2 ACCESSORIES

- A. Flute Closures: Closed cell foam rubber, one inch thick; profiled to fit tight to the decking.
- B. Fasteners:
 - 1. Screws:
 - a. Self-drilling.
 - b. Case hardened and tempered.
 - c. Finish: black phosphate.
 - 2. Powder Actuated Fasteners:
 - a. Provide fastener listed in SDI Diaphragm Design Manual.
 - b. Fasteners are drive pin type, installed with powder actuated tools.
 - c. Provide steel alloy drive pins.
 - 1) Rockwell C hardness of 52 to 56.
 - 2) Zinc plated to minimum thickness of 52 to 56.
 - 3) Knurled conical shaft, ballistic point, and a pre-mounted steel washer 1/2 inch in diameter.
 - 4) Length: approximately 1 inch.

2.3 FABRICATION

- A. Metal Decking: Provide metal deck with thickness, height and flares as indicated on Contract Drawings.
- B. Metal Closure Strips, Wet Concrete Stops, Cover Plates, and Related Accessories: 20 gage galvanized sheet steel; of profile and size to provide tight fitting closure of open ends and side of decking.

END OF SECTION

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SECTION 05 31 23
STEEL ROOF DECKING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel roof deck and accessories.
- B. Architecturally exposed ceiling-deck system and accessories.
- C. Formed steel cant strips, roof sump pans, metal closure strips, hips, valleys, and ridges.
- D. Framing for openings up to and including 18 inches.

1.2 RELATED SECTIONS

- A. Section 05 12 00 - Structural Steel Framing: Structural framed openings larger than 18 inches.
- B. Section 05 31 13 - Steel Floor Decking [05 31 13] - Steel Floor Decking.

1.3 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S100-07/SC-10 – North American Specification for the Design of Cold-Formed Steel Structural Members, with Supplement 2 dated 2010.
 - 2. AISI S200-07 - North American Standard for Cold-Formed Steel Framing - General Provision.
 - 3. AISI S201-07 - North American Standard for Cold-Formed Steel Framing - Product Data.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36-08 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A653-11 - Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
 - 3. ASTM A924-10a – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 4. ASTM A1008-08a - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- C. American Welding Society (AWS):
 - 1. AWS D1.1-10, Structural Welding Code -- Steel.
 - 2. AWS D1.3-98, Structural Welding Code - Sheet Steel.
- A. DOD/ Military Specifications (MIL):
 - 1. DOD-P-21035 A/MIL-P-21035A Paint High Zinc Dust Content, Galvanizing Repair, 2003.
- D. Steel Deck Institute (SDI)
 - 1. SDI Code of Standard Practice - No. COSP, May 2012.
 - 2. Design Manual for Composite Decks, Form Decks, and Roof Decks – No. 31.
 - 3. Diaphragm Design Manual, Third Edition – No. DDM03 September 2004.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.

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- B. Shop Drawings: Indicate
 - 1. Decking plan and erection sequence
 - 2. Support locations, projections
 - 3. Openings and reinforcement
 - 4. End lap and side lap details
 - 5. Pertinent details, and accessories, including type, size and spacing of fasteners
 - 6. Fastener pattern including type, size, and spacing of fastener
 - 7. Temporary shoring of decking where required.
 - 8. Do not make Shop Drawings using reproductions of or making reference to Contract Drawings.

- B. Product Data: Provide manufacturer's specifications and installation instructions for each type of deck and accessory. Provide deck profile characteristics and dimensions, structural properties, and finishes.

- C. Manufacturer's Installation Instructions: Indicate specific installation sequence and special instructions.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum 3 years documented experience.

- B. Manufacturer: Member of Steel Deck Institute.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01 65 00 Product Delivery

- B. Store and protect products under provisions of Section 01 66 00 Product Storage and Handling Requirements.

- C. Cut plastic wrap to encourage ventilation.

- D. Store decking on dry wood sleepers; slope for positive drainage.

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as shown on Shop Drawings.

1.8 SEQUENCING

- 1. Coordinate installation of sound-absorbing insulation strips and non-corrosive spacers (lath when required) in the ribs of cellular acoustical deck to ensure protection of insulation strips against damage from effects of weather and other causes.

- B.

PART 2 - PRODUCTS

2.1 MATERIALS

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- A. Sheet Steel: ASTM A653, Grade 33 Structural Quality; with G90 galvanized coating designation conforming to ASTM A924.
- B. Paint: Manufacturer's baked on, rust inhibitive paint, for application to metal surfaces that have been chemically cleaned and phosphate chemical treated.
- C. Bearing Plates: ASTM A36 steel, unfinished.
- D. Welding Materials: AWS D1.1.
- E. Touch-Up Primer: Zinc chromate type.

2.2 ACCESSORIES

- A. Flute Closures: Closed cell foam rubber, one inch thick; profiled to fit tight to the decking.
- B. Fasteners:
 - 1. Screws: Acceptable manufacturers:
 - a. Manufacturer: Hilti Corporation.
 - 1) Product: Kwik-Pro Self-Drilling Screws.
 - 2) Product Data Publication: Hilti Fastening Technical Guide (H-437-5/89).
 - b. Manufacturer: ITW Buildex
 - 1) Product: Buildex TEKS Self-Drilling Screws.
 - 2) Product Data Publication: ITW Buildex metal Fastening Systems Guide, 1985.
 - c. Manufacturer: Elco Industries, Inc.
 - 1) Product: Dril-Flex.
 - 2) Product Data Publication: Dril-Flex Fastening Guide.
 - 2. Powder Actuated Fasteners:
 - a. Provide fastener listed in SDI Diaphragm Design Manual.
 - b. Fasteners are drive pin type, installed with powder actuated tools.
 - c. Provide steel alloy drive pins.
 - 1) Rockwell C hardness of 52 to 56.
 - 2) Zinc plated to minimum thickness of 52 to 56.
 - 3) Knurled conical shaft, ballistic point, and a pre-mounted steel washer 1/2 inch in diameter.
 - 4) Length: approximately 1 inch.

2.3 FABRICATION

- A. Metal Decking: Sheet steel, configured as follows:
 - 1. Minimum Metal Thickness (Excluding Finish): As indicated on Drawings.
 - 2. Nominal Height: 1-1/2 inch fluted profile to SDI WR.
 - 3. Acoustical Deck: 3 inch cellular profile
 - 4. Side Joints: Lapped
 - 5. Flute Sides: Plain vertical face
- B. Accessories:
 - 1. Metal Closure Strips, 20 gage galvanized sheet steel; of profile and size to provide tight fitting closure of open ends and side of decking.
 - 2. Fabricate roof sump pan of 14 gage sheet steel, flat bottom, sloped sides, recessed 1-1/2 inches below roof deck surface, bearing flange 3 inches wide, sealed watertight.

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3. Cant Strips: Formed sheet steel, 20 gage thick, 45 degree slope, 3-1/2 inch nominal width and height, flange for attachment.
4. Hips, Valleys, and Ridges: Fabricate from 16 gauge, galvanized sheet steel. Fabricate not less than 4 1/2 inches wide and bent to provide tight fitting closure with deck units.
5. Acoustical Treatment Properties
 - a. NCR Rating: 1.0 MINIMUM** NOTE TO SPECIFIER *Acoustical Insulation Batts:
 - b. Factory and Field installed.
 - c. Factory and Field installed over non-corrosive plastic lath spacer.
 - 1) Type: Unwrapped fiberglass, formaldehyde free.
 - 2) Density: 3.0 lbf/ft³ (48 kg/m³).
 - 3) Dimensions: Size as determined by Manufacturer to assure minimum NRC rating value required.

END OF SECTION

SECTION 05 40 00

COLD FORMED STEEL FRAMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non-load bearing formed steel stud exterior wall framing.
- B. Exterior canopy roof framing.

1.2 RELATED SECTIONS

- A. Section 09 29 00 - Gypsum Board: Specifies cold formed steel sections used to support gypsum drywall construction.

1.3 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S100-12/S2-10 – North American Specification for the Design of Cold-Formed Steel Structural Members, with Supplement 2 dated 2010.
 - 2. AISI S200-12 - North American Standard for Cold-Formed Steel Framing - General Provision.
 - 3. AISI S201-12 - North American Standard for Cold-Formed Steel Framing - Product Data.
 - 4. AISI S202-11-Code of Standard Practice for Cold-Formed Steel Structural Framing.
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A123-09 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A653-11 Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
 - 3. ASTM A780-09 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - 4. ASTM A924-10a Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - 5. ASTM C955-11c Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
- C. American Welding Society (AWS)
 - 1. AWS D1.1-09 - Structural Welding Code-Steel.
 - 2. AWS D1.3-98 - Structural Welding Code-Sheet Steel.
- D. DOD/Military Specifications (MIL):
 - 1. DOD-P-21035 A/MIL-P-21035A Paint High Zinc Dust Content, Galvanizing Repair, 2003.
- E. International Building Code, 2018 Edition.
- F. Steel Stud Manufacturers Association (SSMA)
 - 1. 2009 IBC SSMA Product Technical Guide.

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2. SSMA Technical Note No. 2, "Unsheathed Flange Bracing," March 2000
3. SSMA Technical Note No. 3, "Track Within A Track Deflection," April 2000

1.4 SYSTEM DESCRIPTION

- A. Size components to withstand wind load pressures in accord with the International Building Code, 2018 Edition with latest State amendments.
- B. Typical Maximum Allowable Deflection: 1/240 span or as indicated on Drawings.
- C. For studs providing lateral support for brick and stone veneer and stucco, Maximum Allowable Deflection: 1/600 span.
- D. Design wall system to provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
- E. Design system to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Product Data:
 1. Include manufacturer's technical description of:
 - a. Materials.
 - b. Galvanized finish.
 - c. Shapes.
 - d. Connection hardware.
 - e. Load tables.
 - f. Span deflection tables.
 - g. Installation data.
 2. Mark submitted information to indicate only products proposed for use.
 3. Material handling instructions.
- C. Shop Drawings:
 1. Submit Shop Drawings showing:
 - a. Erection procedures.
 - b. Show locations, layout, sizes, gauges, spacing and type of framing components,
 - c. Details of connections.
 - d. Framing of openings.
 2. Indicate all prefabricated framing, if used, with individual panels shown for each condition.
 3. Indicate on the Shop Drawings sequence and method of erection details of all connections of cold formed steel framing to all elements of the building structure.
- D. Provide calculations, sealed by a Professional Structural Engineer registered in the State of Georgia that indicate compliance with design criteria and the Contract Documents.
 1. Indicated compliance with design criteria.
 2. Perform calculations, analysis, and computation of section properties in accordance with the AISI S100 – North American Specification for the Design of Cold-Formed Steel Structural Members.

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- 3. Include:
 - a. Description of design criteria.
 - b. Section properties.
 - c. Allowable stress.
 - d. Engineering analysis depicting member stress and deflection.
 - e. Connections to other building components and the building substrate.

- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

- F. Welder Certification: Submit welders' certifications in accord with AWS D1.1 current within previous twelve months, for Architect's information.

1.6 QUALIFICATIONS

- A. Cold Formed Steel Member Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

- B. Welders employed on the Work must have passed qualification tests required for the work to be installed for this project.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in accordance with the manufacturer's latest specifications.

- B. Deliver material in unbroken bundles with each type of member identified with permanent marking indicating manufacturer's name, member description and gauge.

- C. Store cold-formed material on blocking, pallets, platforms, or other supports off-ground in a position to avoid damage from excessive bending. Store in a dry ventilated space.

- D. Protect cold-formed material and accessories from corrosion, deformation, damage and deterioration when stored on the job site. Keep cold-formed material free from dirt and other foreign matter.

PART 2 - PRODUCTS

2.1 FRAMING MATERIALS

- A. Studs: ASTM A653 sheet steel, Grade C, with minimum yield strength of 50 KSI for members 16 gage and heavier, 33 KSI for members 18 gage and lighter, formed to panel shape, punched web per ASTM C955.

- B. Track: ASTM A653 sheet steel, Grade A, with minimum yield strength of 33 KSI, formed steel; channel shaped; same gage and width as studs, tight fit; solid web per ASTM C955.

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- C. Galvanize with zinc coating conforming to Coating Class G-90 in accordance with ASTM A924.
- D. Supply members manufactured and supplied by one manufacturer.

2.2 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes, same finish as framing members.
- B. Plates, Gussets, Clips: Formed sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes, same finish as framing members.
- C. Touch-Up Primer for Galvanized Surfaces: Premixed, organic zinc liquid containing 95 percent zinc in dried film.

2.3 FASTENERS

- A. For fastening cold formed members to metal deck or cold formed members to each other: self-drilling, self-tapping screws, bolts, nuts and washers: ASTM A123, hot dip galvanized to 1.25 oz/sq. ft. Use sizes recommended by the manufacturer for application indicated.
- B. For fastening cold formed steel to concrete surfaces: powder actuated type galvanized fasteners 0.145 in minimum diameter, capable of withstanding 193 lb. single shear and 200 lb. bearing force without exceeding allowable design stress of fastener or the member being fastened.
- C. For fastening cold formed steel to structural steel framing: welding using electrodes and welding techniques in accord with the manufacturer's product data and in conformance with AWS D1.1 and AWS D1.3.

END OF SECTION

SECTION 05 5000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Steel framing and supports for countertops.
 2. Steel framing and supports for mechanical and electrical equipment.
 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 4. Elevator hoist beams.
 5. Support angles for elevator door sills.
 6. Shelf angles.
 7. Fixed access ladder.
 8. Column Covers
 9. Roof tie-off anchorage.

PART 2 - PRODUCTS

2.1 FIXED ACCESS LADDER

- A. Manufacturer:
1. Basis of Design: O'keeffe's, Inc.: Fixed Access Ladder – Model 500
 - a. Type: Standard Duty Channel Rail
 - b. Material: Aluminum.
- B. Acceptable Manufacturers: Subject to compliance with requirements:
1. Alaco Ladder Company: Model 560.
 2. Grainger: Model WLA6SS.

2.2 COLUMN COVERS

- A. Manufacturer:
1. Basis if Design: Centria NextGen Column Covers
 - a. Series 3000
 - b. Material: Aluminum
 - c. 5/8 inch reveal.

2.3 COMMERCIAL ROOF ANCHOR

- A. Manufacturer
1. Basis of Design: Frontline Fall Protection Model R012
 - a. 12 inch height
 - b. Welded Steel Galvanized Anchorage Device

PART 3 – EXECUTION

END OF SECTION 055000

SECTION 05 51 00

METAL STAIRS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Steel stairs fabricated from steel shapes which are not a part of building structural systems.

1.2 RELATED SECTIONS:

- A. 05 12 00 - Structural Steel Framing
- B. 05 50 00 – Metal Fabrications

1.3 REFERENCES:

- A. American Institute of Steel Construction (AISC):
 - 1. Steel Construction Manual, 14th Edition.
 - 2. Specification for Structural Joints Using High Strength Bolts, Approved by the Research Council for Structural Connections of the Engineering Foundation, December 31, 2009 and endorsed by the AISC.
 - 3. Code of Standard Practice for Steel Buildings and Bridges, March 18, 2005.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36-08 Standard Specification for Structural Steel.
 - 2. ASTM A53-10 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
 - 3. ASTM A325-10 Standard Specification for High Strength Bolts for Structural Steel Joints.
 - 4. ASTM A500-10a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
 - 5. ASTM A501-07 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 - 6. ASTM A563-07a Standard Specification for Carbon and Alloy Steel Nuts.
 - 7. ASTM A568-11b Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements
 - 8. ASTM A992-11 Standard Specification for Structural Steel Shapes.
 - 9. ASTM A1008-08b Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - 10. ASTM A1011-08 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
 - 11. ASTM F436-11 Standard Specification for Hardened Steel Washers.
 - 12. ASTM F959-09 Standard Specification for Compressible - Washer - Type Direct Tension Indicator for Use with Structural Fasteners.
 - 13. ASTM F1554-07ae1 Standard Specification for Anchor Bolts, Steel, 36, 55 and 105 KSI Yield Strength.
 - 14. ASTM F1852-11 Standard Specification for "Twist Off" Type Tension Control Structural Bolt / Nut / Washer / Assemblies, Steel, Heat Treated, 120 / 105 KSI Minimum Tensile Strength.

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- C. American Welding Society (AWS):
 - 1. AWS D1.1-10 Structural Welding Code - Steel.
- D. Steel Structures Painting Council (SSPC):
 - 1. SSPC Painting Manual Volume 2, Systems and Specifications, 2011 Edition.

1.4 SUBMITTALS:

- A. Submit under provisions of Section 01 33 00 Submittal Procedures.
- B. Shop Drawings: Submit Shop Drawings for fabrication and erection of stair work that include but are not limited to the following.
 - 2. Indicate profiles, sizes, spacing, and locations of structural members and openings.
 - 3. Connections.
 - 4. Indicate welds by standard AWS symbols. Show size length and type of each weld.
 - 5. Provide setting drawings, templates, and directions for installation of anchor bolts and other anchorages.
 - 6. Show anchorage and accessory items.
 - 7. Do not make Shop Drawings using reproductions of or making reference to Contract Drawings.
 - 8. Provide signed and sealed Shop Drawings prepared under the supervision of a Professional Engineer registered in the state of Georgia experienced in steel stair design.
- C. Submit design calculations for the stairs with the Shop Drawings.
 - 1. Design stairs for a 100 PSF live load.
 - 2. Provide signed and sealed design calculations demonstrating conformance with the specified performance requirements, that have been performed by a Professional Engineer registered in the state of Georgia experienced in steel stair design.
- D. Welders' Certificates: Submit welders' certificates for each welder to be employed on this project. Certificates to indicate welder has been tested on type of weld in last 12 months.

1.5 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC - Steel Construction Manual, 14th Edition.
- B. Field measurements:
 - 1. Take field measurements prior to preparation of Shop Drawings and fabrication, where possible, to insure fitting of work, however, do not delay job progress.
 - 2. Allow for trimming and fitting wherever taking of field measurements before fabrication might delay work.

1.6 QUALIFICATIONS

- A. Welder: Employ welders on the Work that have successfully qualified for the welding positions required in accordance with Chapter 5 "Qualification," AWS D1.1 Qualification, within the last 12 months. Welders are required to carry proof of their qualification on their person.

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PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Structural Steel Shapes
 - 1. W-Shapes: ASTM A992, Grade 50.
 - 2. M-Shapes: ASTM A36.
 - 3. S-Shapes: ASTM A36.
 - 4. HP-Shapes: ASTM A36.
 - 5. Channels: ASTM A36.
 - 6. Angles: ASTM A36.
 - 7. Structural Tees: ASTM A992, Grade 50.

- B. Structural Steel Plates and Bars: ASTM A36.

Cold Formed Steel Tubing: ASTM A500, Grade C.

- C. Hot Formed Steel Tubing: ASTM A501. Type E or S, Grade B.

- D. Pipe: ASTM A53 Type E or S, Grade B.

- E. High Strength Bolts: All material, domestic manufacture, marked with lot identification.
 - 1. High strength bolts:
 - a. Standard bolts: ASTM A325, or ASTM A490, type I.
 - b. Alternate design bolts: Conforming to ASTM F1852.
 - 1) NSS Industries, Rapid Tension Bolts.
 - 2) Le Jeune Bolt Company, Tension Control Bolts.
 - 3) Bethlehem Steel Corporation, Load Indicator Bolt.
 - 4) Substitutions: Under provisions of Section 01 25 13 Product Substitution Procedures.
 - 2. Nuts: ASTM A563.
 - 3. Washers:
 - a. Hardened steel washers: ASTM F436.
 - b. Direct tension indicator washer (Load Indicator Washer): ASTM F959.

- F. Anchor Rods: ASTM F1554, Grade 36.

- G. Electrodes for welding in accordance with AWS D1.1.

- H. Hot-rolled carbon steel sheets and strips: ASTM A568 and ASTM A1011; Grade B.

- I. Cold-rolled carbon steel sheets: ASTM A1008.

- J. Standard bolts and nuts: ASTM A325, Grade A, regular hexagon head. Nuts meeting ASTM A563, Hex Grade C.

- K. Machine screws: Cadmium plated steel.

- L. Shop Paint and Touch-Up Primer
 - 1. Shop paint for interior steel:
 - a. Type: Modified soya oil alkyd resin - lead and chromate free.
 - b. Solids Content: 55%
 - 2. Shop paint for exterior steel:
 - a. Vehicle type: Inorganic Ethyl Silicate (self-curing).
 - b. Pigment type: Zinc dust plus colorant (green).
 - c. Pigment content: 85% Zinc dry film by weight.

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- d. Solids content: 79% by weight, 71% by volume packing density ratio of wet to dry film.

2.2 FABRICATION:

- A. General: In accordance with the References.
- B. Workmanship: Use materials of size indicated. Work to dimensions shown on approved Shop Drawings using proven details of fabrication and support. Use materials indicated for the various components of work.
- C. Metal Surfaces:
 - 1. For fabrication of steel stair work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.
 - 2. Remove such blemishes by grinding or by welding and grinding prior to cleaning, treating, and application of surface finishes including zinc coatings.
- D. Form work true to line and level with accurate angles and surfaces and straight sharp edges.
 - 1. Ease exposed edges to radius of approximately 1/32 inches.
 - 2. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Welded corners and seams continuously and in accordance with recommendations of AWS. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces.
- F. Provide for anchorage of type shown on approved Shop Drawings coordinated with supporting structure. Fabricate and space anchoring devices as required providing adequate support.
- G. Remove scale, rust and other deleterious materials before applying shop primer. Apply one shop coat of metal primer to fabricated metal items.
- H. Use welding for joining pieces together, unless otherwise shown.
 - 1. Fabricate units so that bolts and other fastenings do not appear on finish surfaces.
 - 2. Make joints true and tight.
 - 3. Provide continuous welds, ground smooth where exposed.
- I. Construct stair units to conform to sizes and arrangements shown.
 - 1. Construct entire assembly to support minimum live load of 100 lbs./sq. ft.
 - 2. Provide metal framing, hangers, struts, clips, brackets, bearing plates and other components as required for support of stairs and platforms.
 - 3. Erect stair work to line, plumb, square and true with runs registering level with floor and platform levels.
- J. Provide brackets and bearing surfaces as required to anchor and contain the stairs on the supporting structure.
- K. Fabricate stringers of structural steel channels or plates, or combination thereof. Provide closures for exposed ends of stringers.
- L. Construct platforms of structural steel channel headers and miscellaneous framing

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members, as shown. Bolt headers to stringers and newels. Bolt framing members to stringers and headers.

M. Metal pan units:

1. Form metal pans of 0.1046 inch thick structural steel sheet. Shape pans to conform to configuration shown on Contract Drawings.
2. Construct riser and subtread metal pans with steel angle supporting brackets, welded to stringers. Secure metal pans to brackets with rivets or welds.
3. Secure sub-platform metal pans to platform frames with welds.

2.3 STEEL LADDERS:

- A. Fabricate vertical steel ladders of hot rolled 3/4 inch by 2-3/4 inch steel rails and 3/4 inch round steel rungs extending through rails with full welded connections. Space rungs 12 inches on center maximum.
- B. Anchor ladders at top and bottom points. Provide anchor brackets of length to hold ladder 7 inches from walls. Anchor to masonry walls using 3/8 inch diameter bolts in expansion shields.
- C. At parapet ladder, return rails across parapet as detailed and secure to back side of parapet using 3/8 inch toggle bolts. Provide grating stop over parapet.

END OF SECTION

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Cable Railing System.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: AGS Stainless: Ranier Cable Railing System.

PART 3 - EXECUTION

END OF SECTION 055213

SECTION 061000 – ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes wood furring, grounds, nailers, and blocking
- B. Locations for use of fire retardant plywood, wood furring, grounds, nailers, and blocking shall comply with the Code and with the requirements of the authorities having jurisdiction.
- C. Install new wood blocking to match finish roof membrane system insulation heights, at roof perimeters, walls, penetrations, and as required to properly terminate the roofing and flashing membranes.

PART 2 - PRODUCTS

2.1 PRESSURE TREATMENT OF WOOD

- A. Water Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propenyl butyl carbonate (IPBC) as its active ingredient.
 - 1. Preservative Treatment
 - 2. Fire Retardant Treatment (plywood backing panels only).

2.3 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant-strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.

2.4 STRUCTURAL-USE PANELS FOR BACKING

- A. Plywood Backing Panels: For mounting electrical or telephone equipment, provide fire-retardant-treated plywood panels with grade, C-D Plugged Exposure 1, in thickness indicated or, if not otherwise indicated, not less than 15/32 inch thick.
 - 1. Plywood product shall be urea-formaldehyde free. The use of phenol-formaldehyde resins is allowable.

2.5 FASTENERS

PART 3 - EXECUTION

END OF SECTION 061000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Rooftop equipment bases and support curbs.
 - 2. Wood blocking, cants and nailers.
 - 3. Plywood backing panels.
- B. Related Sections include the following:
 - 1. Section 061600 Sheathing.

PART 2 - PRODUCTS

2.1 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWPA C20 (lumber).
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Use Exterior type for exterior locations and where indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Application: Treat all miscellaneous carpentry, unless otherwise indicated.
 - 1. Framing for raised platforms.
 - 2. Concealed blocking.

2.2 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.

2.3 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

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PART 3 - EXECUTION

END OF SECTION 061053

SECTION 061643 – GYPSUM SHEATHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fiberglass-mat faced sheathing at locations indicated on drawings.

1.2 REFERENCES

- A. Versions of the following standards current as of the date of issue of the project apply to the Work of this Section.
 1. ASCE 7 Minimum Design Loads for Buildings
 2. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
 3. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 4. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 5. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 6. ASTM C1280 Standard Specification for Application of Gypsum Sheathing.
 7. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 8. ASTM D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers.
 9. ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
 10. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
 11. ASTM C1396 Standard Specification for Gypsum Board
 12. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
 13. GA 216 Application and Finishing of Gypsum Panel Products
 14. GA 253 Application of Gypsum Sheathing
 15. GA 600 Fire Resistance Design Manual

1.3 WARRANTY

- A. Special Manufacturer's Warranty: Five years against manufacturing defects from the date of purchase of the product for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Georgia-Pacific Gypsum LLC

1. Type: DensGlass Fireguard
 - a. Thickness: 5/8 inches.

2.2 ACCESSORIES

- A. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members;
#6 corrosion-resistant bugle head screws or manufacturer approved equivalent.

PART 3 - EXECUTION

END OF SECTION 061643

SECTION 06 4023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Plastic laminate cabinets.
 - 2. Solid surfacing material countertops
 - 3. Plastic laminate countertops.

- B. Steel framing for millwork, refer to Section 055000, Metal Fabrications.

PART 2 - PRODUCTS

- A. Basis of Design: FORMICA
- B. Cabinet Hardware and Accessories
- C. Marine grade plywood at countertops with sinks.

PART 3 - EXECUTION

END OF SECTION 064023

SECTION 071616 - CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes crystalline waterproofing applications to interior surfaces of below grade moisture cured elevator pit walls.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Crystalline Waterproofing:
 - a. Xypex Chemical Corporation; Xypex.
 - b. ThoRoc, Div. of ChemRex; Tegraproof.
 - c. Vandex International Ltd.; Vandex Super.

PART 3 - EXECUTION

END OF SECTION 071616

SECTION 072100 –THERMAL INSULATION

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Perimeter insulation under slab on grade.
 - 2. Concealed building insulation.
 - 3. Vapor barrier.
 - 4. Sound attenuation insulation.

PART 2 - PRODUCTS

2.1 CONCEALED RIGID BUILDING INSULATION

- A. Manufacturer
 - 1. Basis of Design: Owens Corning Foam Insulation
 - a. Roofing – Foamular Thermapink: Extruded Polystyrene (XPS).
 - b. Walls – Foamular CW25 XPS Insulation
- B. Acceptable Manufacturers: Subject to compliance with requirements:
 - 1. Dow Chemical Company
 - 2. DiversiFoam Products.

2.2 CONCEALED BLANKET BUILDING INSULATION/ SOUND INSULATION

- A. Manufacturer:
 - 1. Basis of Design: Owens Corning Insulating Systems
 - a. Type: Fiberglas Insulation; Unfaced.
- B. Acceptable Manufacturers: Subject to compliance with requirements:
 - 1. Fibrex Insulations Inc.
 - 2. Thermafiber.

2.3 VAPOR BARRIER: Vapor permeable membrane

- A. Basis of Design: GCP Perm-a Barrier VPL

PART 3 - EXECUTION

END OF SECTION 072100

SECTION 07 2726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Fluid-applied, membrane air and vapor barrier.

1.2 DEFINITIONS

- A. ABAA: Air Barrier Association of America.
- B. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.3 QUALITY ASSURANCE

- A. Mockups: Before beginning installation of air barrier, build mockups of exterior wall assembly 150 sq. ft., incorporating backup wall construction, external cladding, window, door frame and sill, insulation, and flashing to demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of air barrier membrane.
 - 1. Coordinate construction of mockup to permit inspection by Owner's testing agency of air barrier before external insulation and cladding is installed.
 - 2. Include junction with roofing membrane, building corner condition [and foundation wall intersection.
 - 3. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
 - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air barrier manufacturer.
- B. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- C. Store rolls according to manufacturer's written instructions.
- D. Protect stored materials from direct sunlight.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 FLUID-APPLIED MEMBRANE AIR BARRIER

- A. Fluid-Applied, Vapor-Permeable Membrane Air Barrier: Elastomeric, modified bituminous membrane.
1. Basis of Design: Carlisle Coatings & Waterproofing
 - a. Product: Bariseal S.
 2. Acceptable Products: Subject to compliance with requirements, provide one of the following:
 - 1) Henry Company; Air-Bloc 07.
 - 2) BASF: Enershield
 3. Physical and Performance Properties:
 - a. Membrane Air Permeance: Not to exceed 0.004 cfm/ sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
 - b. Membrane Vapor Permeance: Not less than 4 perms; ASTM E 96.

2.2 AUXILIARY MATERIALS

PART 3 - EXECUTION

END OF SECTION 072726

SECTION 07 4213 – METAL WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal wall panels.
 - a. Concealed fastener attachment.

PART 2 - PRODUCTS

2.2 METAL WALL PANELS

- A. Manufacturer:
 - 1. Basis of Design: Centria Concept Series Wall System # CS-200
 - a. Material: Aluminum
 - b. Attachment: Concealed Fastener Panel.
 - c. Depth: 7/8 inches.
 - d. Texture: Smooth
- B. Acceptable Manufacturers:
 - 1. NexGen Design Systems Inc.: Expression Plus System
 - 2. MBCI Systems: Concealed Fastener Metal Wall System.

PART 3 - EXECUTION

END OF SECTION 074000

SECTION 07 5400 – THERMOPLASTIC MEMBRANE ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Fully Adhered Roofing System
 2. Insulation
 3. Walkway Rolls
 4. Flashing
 5. Coping System

PART 2 - PRODUCTS

2.1 ROOFING SYSTEM

- A. Products:
1. Membrane: White reinforced 60 mil-thick single ply Thermoplastic Polyolefin (TPO) Fully Adhered Roofing System
 2. Insulation: FM approved polyiso insulation
 3. Accessories: Includes fasteners and plates; metal edging and membrane terminations; adhesives and cleaners recommended by membrane manufacturer.
 4. Heat Weldable Walkway Rolls/Pads: Heat weldable permanent fuse to membrane.
- B. Manufacturer:
1. Basis of Design: GAF Materials Corporation: EverGuard.
 - a. Weight: 256lbs Full Size.
 - b. Roll Size: 10 ft x 100 ft.
 - c. Surface: Smooth.
- C. Acceptable manufacturers:
1. Carlisle SynTec Incorporated
 2. Duro-Last Roofing Systems
 3. Firestone Building Systems

C. EXECUTION

END OF SECTION 075400

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
 - 1. Formed wall flashing and trim.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. Aluminum Sheet: ASTM B 209, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
 - 1. Anodized Finish: Apply the following coil-anodized finish:

2.2 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond. Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing.
- B. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory- mitered and -welded corners and junctions.
 - 1. Manufacturers:
 - a. Cheney Flashing Company, Inc.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products Inc.
 - d. Hickman, W. P. Company.

PART 3 - EXECUTION

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Equipment supports.
 - 2. Roof hatches.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and mill finish.
 - 1. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: Nonspecular as fabricated; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

2.2 MISCELLANEOUS MATERIALS

- A. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.

2.3 EQUIPMENT SUPPORTS

- A. Equipment Supports: Provide metal equipment supports, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported. Fabricate with welded or sealed mechanical corner joints, with stepped integral metal cant raised to the thickness of roof insulation and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
 - 1. Acceptable Manufacturers:
 - a. Pate Company (The).
 - b. Roof Products & Systems Corporation.
 - c. Thaler Metal Industries Ltd.
 - d. ThyCurb; Div. of Thybar Corporation.
 - 2. Material: Galvanized, 0.079 inch thick.
 - 3. Factory-install continuous wood nailers 3-1/2 inches wide at tops of equipment supports.
 - 4. Metal Counterflashing: Manufacturer's standard removable counterflashing, fabricated of same metal and finish as equipment support.
 - 5. Fabricate units to minimum height of 12 inches, unless otherwise indicated.

2.4 ROOF HATCHES

- A. Roof Hatches: Fabricate roof hatches with insulated double-wall lids and insulated single-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints. Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.
1. Basis of Design: The Bilco Company – Model E50-TB
 2. Acceptable Manufacturers:
 - a. Babcock-Davis; a Cierra Products Inc. Company.
 - b. Custom Curb, Inc.
 - c. Dur-Red Products.
 - d. J. L. Industries, Inc.
 3. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.
 4. Type and Size: Single-leaf lid, 36" x 36"
 5. Curb and Lid Material: Aluminum sheet, 0.090 inch thick.
 6. Insulation: Polyisocyanurate board.
 7. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.

PART 3 EXECUTION

END OF SECTION 07 7200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application on Drawings, that are produced by one of the following manufacturers:
 1. A/D Fire Protection Systems Inc.
 2. Grace, W. R. & Co. - Conn.
 3. Hilti, Inc.
 4. Johns Manville.
 5. NUCO Inc.
 6. 3M; Fire Protection Products Division.
 7. Tremco; Sealant/Weatherproofing Division.
 8. USG Corporation.

PART 3 - EXECUTION

END OF SECTION 078413

SECTION 07 9200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes joint sealants for the following applications:
1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - 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.
 2. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
 - e. Joints between plumbing fixtures and adjoining walls, floors, and counters.

PART 2 - PRODUCTS

2.1 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Multi-component Nonsag Neutral-Curing (non-staining) Silicone Sealant:
1. Products:
 - a. Tremco, Inc.: Spectrum 3 and Spectrum 4
 - b. Dow Corning Corporation
 2. Type and Grade: M (multi-component).
 3. Class: 50.
 4. Use Related to Exposure: NT (non-traffic).
 - a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, brick, ceramic tile and terrazzo.

2.2 LATEX JOINT SEALANTS

- A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.
- B. Products:

1. Bostik Findley; Chem-Calk 600.
2. Pecora Corporation; AC-20+.
3. Schnee-Morehead, Inc.; SM 8200.
4. Sonneborn, Division of ChemRex Inc.; Sonolac.
5. Tremco; Tremflex 834.

2.3 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following:
1. 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.
 2. Products:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.
 - c. Tremco: Tremco Acoustical Sealants.

2.4 PREFORMED JOINT SEALANTS

- A. Preformed Silicone-Sealant System: Manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.
1. Products:
 - a. Dow Corning Corporation; 123 Silicone Seal.
 - b. GE Silicones; UltraSpan US1100.
 - c. Pecora Corporation; Sil-Span.
 - d. Tremco; Spectrem Ez Seal.

PART 3 - EXECUTION

END OF SECTION 079200

SECTION 081113 – HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard rated and non-rated hollow metal doors and frames.
 - a. Exterior and interior.

PART 2 - PRODUCTS

2.1 STANDARD HOLLOW METAL DOORS

A. Basis of Design: Mesker Door, Inc.

1. Exterior Doors:
 - a. Door models in first subparagraph below have 0.032-inch- (0.8-mm-) thick faces.
 - b. Level III and Physical Performance Level C (Extra Heavy Duty), Model 2.
2. Exterior Frames: Fabricated from galvanized coated steel sheet. Standard face weld and ground smooth. Continuous full depth weld. 12 gauge.
3. Interior Doors:
 - a. Level III and Physical Performance Level A (Heavy Duty), Model 2.
 - b. Interior Frames: Fabricated from cold-rolled steel sheet, standard face weld and ground smooth. 16 gauge.

B. Acceptable Manufacturers: Subject to compliance with the requirements:

1. Ceco Door Products
2. Fleming Door Products

2.2 STEEL FINISHES

A. Factory-Applied Paint Finish: ANSI/SDI A250.3.

1. Color and Gloss: Match Architect's sample.

PART 3 - EXECUTION

END OF SECTION 081113

SECTION 08 11 73 - STEEL FIREDOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Rolling Fire Door.

PART 2 - PRODUCTS

2.1 ROLLING METAL FIRE DOORS

- A. Basis-of-Design Product: Cornell Rolling Fire Door
 - 1. Model ERD10
 - 2. Alarm Activated
 - 3. Powder coated finish.

PART 3 - EXECUTION

END OF SECTION 081173

SECTION 081416 – FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors faces, rated and non-rated.
 - a. Wire glass vision lites.
 - 2. Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceco Door Products
 - 2. Algoma Hardwoods, Inc.
 - 3. Ampco, Inc.
 - 4. Buell Door Company Inc.
 - 5. Chappell Door Co.

2.2 DOOR CONSTRUCTION, GENERAL

- A. WDMA I.S.1-A Performance Grade:
 - 1. Heavy Duty unless otherwise indicated.

2.3 FACTORY FINISHING

- A. Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.

PART 3 - EXECUTION

END OF SECTION 081416

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Exterior aluminum-framed storefronts.
 - a. Glazing is retained mechanically with gaskets on four sides.
 - 2. Exterior manual-swing wide stile heavy duty doors
 - 3. Interior manual-swing wide stile aluminum doors.
 - 4. Interior aluminum door frames.
 - 5. Sunshades

PART 2 - PRODUCTS

2.1 STOREFRONT MANUFACTURERS

- A. Basis of Design: Kawneer Trifab VG Series 415UT.
 - 1. Frame: 2" x 4 1/2"
 - 2. Doors: Wide Stile
 - 3. Rails: 8 inch top rail; 10 inch bottom rail; 6 inch vertical rails.
 - 4. Front Glazed.
- B. Acceptable Manufacturers: Subject to compliance with requirements:
 - 1. YKK AP America
 - 2. Tubelite Inc.
 - 3. United States Aluminum.
 - 4. Vistawall Architectural Products.

2.2 SUNSHADE MANUFACTURERS

- A. Basis of Design: Kawneer: Versoleil Sunshade Outrigger and Single Blade

PART 3 - EXECUTION

END OF SECTION 084113

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.
 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
 2. Electromechanical door hardware.
 3. Automatic operators.
 4. Cylinders specified for doors in other sections.
- C. Related Sections:
1. Division 06 Section "Rough Carpentry".
 2. Division 06 Section "Finish Carpentry".
 3. Division 08 Section "Operations and Maintenance".
 4. Division 08 Section "Door Schedule".
 5. Division 08 Section "Hollow Metal Doors and Frames".
 6. Division 08 Section "Flush Wood Doors".
 7. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
 8. Division 08 Section "Automatic Door Operators".
- 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. ULC-S319 - Electronic Access Control Systems.
 5. ULC-60839-11-1, Alarm and Electronic Security Systems - Part 11-1: Electronic Access Control Systems - System and Components Requirements.
 6. UL 305 – Panic Hardware.
 7. ULC-S132, Emergency Exit and Emergency Fire Exit Hardware.
 8. ULC-S533 – Egress Door Securing and Releasing Devices.
 9. ANSI/UL 437- Key Locks.
 10. ULC-S328, - Burglary Resistant 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.
- F. 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.

1.4 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 demonstrating compliance with the referenced 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 to manufacturer's instructions and recommendations and according to approved schedule.

1.5 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".

1.6 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 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.

1.7 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. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified 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: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
5. Manufacturers:
 - a. Hager Companies (HA).
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - MacPro Series.
 - c. Stanley Hardware (ST).

2.3 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
 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. Door Controls International (DC).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).
- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls 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. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 5. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (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.
- B. Cylinders: Original manufacturer cylinders complying with the following:
 - 1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
 - 2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 - 4. 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.
 - 5. Keyway: Match Facility Standard.
- C. Interchangeable Cores: Provide small format interchangeable cores as specified, core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Permanent Cores: Match standard. Reference Division 01 for material required under project. Installation to be included under Division 08 "Door Hardware" base bid package.
- E. 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.
- F. 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).
- G. Construction Keying: Provide construction master keyed cylinders.
- H. Construction Keying: Provide temporary keyed construction cores.
- I. Key Registration List (Bitting List):
 - 1. Furnish a list of opening numbers with locking devices, showing cylinder types and quantities required when cylinders or cores are to be owner furnished.

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 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) – ML2000 Series.
- B. Cylindrical Locksets, Grade 1 (Commercial Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed.
 1. Locks are to be non-handed and fully field reversible.
 2. Manufacturers:
 - a. Cal Royal (CA) – Genesys Series.

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 ELECTRIC STRIKES

- A. Surface Mounted Rim Electric Strikes: Surface mounted rim exit device electric strikes tested to ANSI/BHMA A156.31, Grade 1, and UL Listed for both Burglary Resistance and for use on fire rated door assemblies. Construction includes internally mounted solenoid with two heavy-duty, stainless steel locking mechanisms operating independently to provide tamper resistance. Strikes

tested for a minimum of 500,000 operating cycles. Provide strikes with 12 or 24 VDC capability supplied standard as fail-secure unless otherwise specified. Option available for latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike. Strike requires no cutting to the jamb prior to installation.

1. Manufacturers:

- a. HES (HS) - 9400/9500/9600/9700/9800 Series.

- B. Provide electric strikes with in-line power controller and surge suppressor by the same manufacturer as the strike with the combined products having a five year warranty.

2.9 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Commercial Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Fabricate latchbolts from cast stainless steel, Pullman type, incorporating a deadlocking feature.

1. Manufacturers:
 - a. Cal Royal (CA) – 5000 Series.

2.10 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 (Large Body Cast Iron): 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 body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:
 - a. LCN Mfg (LC) – 4040XP Series.
 - b. Norton Door Controls (NO) – 9500 Series.

2.11 ELECTROMECHANICAL DOOR OPERATORS

- A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
 - 1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- B. Standard: Certified ANSI/BHMA A156.19.
- C. Performance Requirements:
 - 1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 - 2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.
- D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.
- E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19.
- F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- I. Wireless Interface: Operator units shall have a wireless interface via a mobile device for ease of installation and setup.
- J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Norton Door Controls (NO) - 6300 Series.
 - 2. Besam Automated Entrance Systems (BE) – SW200i Series.

2.12 SURFACE MOUNTED CLOSER HOLDERS

- A. Electromagnetic Door Holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to

accommodate.12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.

1. Manufacturers:
 - a. Rixson (RF) - 980/990 Series.
 - b. Sargent Manufacturing (SA) - 1560 Series.

2.13 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 certified 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. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.14 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 certified 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. Hiawatha, Inc. (HI).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- c. Trimco (TC).

2.15 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 NPFA 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 Products; ASSA ABLOY Architectural Door Accessories (PE).
 3. Reese Enterprises, Inc. (RE).

2.16 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. 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. Manufacturers:

- a. Securitron (SU) - AQD Series.

C. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Manufacturers:

- a. Securitron (SU) - AQL Series.

2.17 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.

2.18 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. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 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. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. 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" and "Cash Allowances". 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.
2. Submit documentation of incomplete items in the following formats:
 - a. PDF electronic file.
 - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

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.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. RO - Rockwood
3. CA - Cal-Royal
4. HS - HES
5. LC - LCN Closers
6. NO - Norton
7. RF - Rixson
8. PE - Pemko
9. SU - Securitron

BUILDING 100

Hardware Sets

Set: 1.0

Doors: 481, 482

Description: ADVISE ROOM

3 Silencer	608		RO
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Set: 2.0

Doors: 220A, 884A

Description: EXT PR - HM - EAC

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	
1 Mullion	CR910KM		RU	
1 Rim Exit Device, Nightlatch	ED5200 L957ET M92 MELR	630	RU	↗
1 Rim Exit Device, Dummy	ED5200 21L950ET	630	RU	
2 Housing - SFIC	As required CT7D	626		
2 Core (as required)	Provided by owner			
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC	
1 Automatic Opener	6300 series - Mtg as required	689	NO	↗
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO	
1 Threshold	271A MSES25SS		PE	
1 Gasketing	303AS		PE	
1 Rain Guard	346C x LAR		PE	
2 Sweep	3452AV		PE	
1 Astragal	S772D [mtg on mull]		PE	
1 Card Reader	By security supplier			↗
1 Electric Power Transfer	EL-CEPT		SU	↗
1 Wall actuator (Touchless)	700		NO	↗

2 Position Switch	DPS-M/W-WH (as required)	SU	⚡
1 Power Supply	AQLX-E1 - Size as required	SU	⚡

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure
 During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: 3.0

Doors: 1086, 217D, 220B, 884B, 884C, 884D, 967

Description: EXT PR - ENTRY

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Removable Mullion	ICLCKUL 424	PC	CA
1 Rim Exit Device, Classroom	5000 EO X SPA ENT00L	630	CA
1 Rim Exit Device, Dummy	5000 EO SPA DUM40L	630	CA
2 Housing - SFIC	As required CT7D	626	
2 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
2 Sweep	3452AV		PE
1 Astragal	S772D [mtg on mull]		PE

Set: 4.0

Doors: 884E

Description: VEST PR - HM - EAC

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Mullion	CR910KM		RU
1 Rim Exit Device, Nightlatch	ED5200 L957ET M92 MELR	630	RU ⚡
1 Rim Exit Device, Dummy	ED5200 21L950ET	630	RU
2 Housing - SFIC	As required CT7D	626	
2 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Automatic Opener	6300 series - Mtg as required	689	NO ⚡
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Gasketing	S88D		PE
2 Sweep	315CN		PE
1 Astragal	S772D [mtg on mull]		PE
1 Card Reader	By security supplier		⚡
1 Electric Power Transfer	EL-CEPT		SU ⚡
1 Wall actuator (Touchless)	700		NO ⚡
2 Position Switch	DPS-M/W-WH (as required)		SU ⚡
1 Power Supply	AQLX-E1 - Size as required		SU ⚡

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure
 During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: 5.0

Doors: 884F, 884G, 884H
 Description: VEST PR - HM

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Removable Mullion	ICLCKUL 424	PC	CA
2 Rim Exit Device, Exit Only	5000 EO	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Gasketing	S88D		PE
2 Sweep	315CN		PE
1 Astragal	S772D [mtg on mull]		PE

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure
 During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: 6.0

Doors: 968
 Description: VEST PR - HM

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
2 Door Pull	BF168	US32D	RO
2 Push Bar	47-PB	US32D	RO
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Gasketing	S88D		PE
2 Sweep	315CN		PE
1 Astragal set	18061CNB		PE
2 Position Switch	DPS-M/W-WH (as required)		SU ↘

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure

During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: 7.0

Doors: 201B, 205B, 207B, 211B

Description: EXT CORR - HM

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Rim Exit Device, Nightlatch	5000 EO X SPA STR05L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
1 Sweep	3452AV		PE

Set: 8.0

Doors: 907A

Description: EXT - STUDY - HM

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Rim Exit Device, Classroom	5000 EO X SPA ENT00L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
1 Sweep	3452AV		PE

Set: 9.0

Doors: 983

Description: CORR PR - RATED

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
2 Fire Rated Surf Vert Rod, Classroom	TF5000 V EO SPA ENT00L	630	CA
2 Housing - SFIC	As required CT7D	626	
2 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Electromagnetic Holder	980 / 990 series	689	RF ✕
1 Gasketing	S88D		PE
1 Astragal	S772D		PE

Set: 10.0

Doors: 217

Description: LIBRARY PR

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
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1 Removable Mullion	ICLCKUL 424	PC	CA
1 Rim Exit Device, Classroom	5000 EO X SPA ENT00L	630	CA
1 Rim Exit Device, Dummy	5000 EO SPA DUM40L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Door Stop	409 / 446 as required	US26D	RO
2 Silencer	608		RO

Set: 11.0

Doors: 201C, 209C, 209D

Description: PASSAGE - UN-EQ PR

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Silencer	608		RO

Set: 12.0

Doors: 981

Description: STUDENT LOUNGE -PR

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Deadlock	ICT-220	626	CA
2 Door Pull	BF168	US32D	RO
2 Push Bar	47-PB	US32D	RO
2 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Door Stop	409 / 446 as required	US26D	RO
2 Silencer	608		RO

Set: 13.0

Doors: 402

Description: LIBRARY - PANIC

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Fire Rated Rim Exit, Classroom	F5000 EO L X SPA ENT00L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: 14.0

Doors: 304, 402A

Description: ENTRY

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Entrance Lock	ICSL-00	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: 15.0

Doors: 202, 207A

Description: LAB - PR

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Classroom Lock	ICSL-03	626	CA
1 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE
1 Astragal	S772D		PE

Set: 16.0

Doors: 402K

Description: BREAK

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Passage Latch	SL-30	626	CA
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: 17.0

Doors: 304D

Description: STOR

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: 18.0

Doors: 217A, 217C, 304A, 304B, 304C, 304E, 304F, 304G, 304H, 402B, 402C, 402D

Description: OFFICE

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Entrance Lock	ICSL-00	626	CA
1 Core (as required)	Provided by owner		

1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: 19.0

Doors: 201A, 203, 205A, 211A, 403
 Description: CLASS

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	ICSL-03	626	CA
1 Core (as required)	Provided by owner		
1 Automatic Opener	6300 series - Mtg as required	689	NO ✕
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: 20.0

Doors: 209A
 Description: CHEM LAB

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	ICSL-03	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: 21.0

Doors: 217B, 402E, 402F, 402G, 402H, 402I, 402J, 402L, 402M, 402N
 Description: CONF / STUDY

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Passage Latch	SL-30	626	CA
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

BUILDING B

Hardware Sets

Set: B1.0

Doors: B. 100A
 Description: EXT PR - HM - EAC

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Mullion	CR910KM		RU
1 Rim Exit Device, Nightlatch	ED5200 L957ET M92 MELR	630	RU ✕
1 Rim Exit Device, Dummy	ED5200 21L950ET	630	RU

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2 Housing - SFIC	As required CT7D	626	
2 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Automatic Opener	6300 series - Mtg as required	689	NO ↗
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
2 Sweep	3452AV		PE
1 Astragal	S772D [mtg on mull]		PE
1 Card Reader	By security contractor		↗
1 Electric Power Transfer	EL-CEPT		SU ↗
1 Wall actuator (Touchless)	700		NO ↗
2 Position Switch	DPS-M/W-WH (as required)		SU ↗
1 Power Supply	AQLX-E1 - Size as required		SU ↗

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure
 During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: B3.0

Doors: [B. 101A](#), [B. 101B](#), [B. 122A](#)
 Description: EXT STAIR PR [EO]

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Removable Mullion	ICLCK 424	PC	CA
2 Rim Exit Device, Dummy	5000 EO SPA DUM40L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
2 Sweep	3452AV		PE
1 Astragal	S772D [mtg on mull]		PE

Set: B4.0

Doors: [B. 100C](#)
 Description: VEST PR - HM - EAC

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Removable Mullion	ICLCK 424	PC	CA
1 Rim Exit Device, Nightlatch	5000 EO X SPA STR05L	630	CA
1 Rim Exit Device, Dummy	5000 EO SPA DUM40L	630	CA
2 Housing - SFIC	As required CT7D	626	

2 Core (as required)	Provided by owner		
1 Electric Strike	9600/9700-LBM X 2005m3	630	HS ↘
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Automatic Opener	6300 series - Mtg as required	689	NO ↘
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Gasketing	S88D		PE
2 Sweep	315CN		PE
1 Astragal	S772D [mtg on mull]		PE
1 Card Reader	By security contractor		↘
1 Wall actuator (Touchless)	700		NO ↘
2 Position Switch	DPS-M/W-WH (as required)		SU ↘
1 Power Supply	AQLX-E1 - Size as required		SU ↘

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure
 During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: B5.0

Doors: B. 100D

Description: VEST PR - HM

6 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Removable Mullion	ICLCK 424	PC	CA
1 Rim Exit Device, Dummy	5000 EO SPA DUM40L	630	CA
2 Housing - SFIC	As required CT7D	626	
2 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Gasketing	S88D		PE
2 Sweep	315CN		PE
1 Astragal	S772D [mtg on mull]		PE

Notes: Door normally closed and secured.
 Authorized credential retracts the latchbolt to allow free entry, door relocks upon closing. REX (request to exit) switch in device rail allow for free exit at all times
 Entry by key override at all times
 Door is fail secure
 During daytime hours exit device may be manually or electronically "dogged" to allow door to be push/pull (free access/egress).

Set: B6.0

Doors: B. 102

Description: EXT - STUDY - HM

3 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
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1 Rim Exit Device, Classroom	5000 EO X SPA ENT00L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
1 Sweep	3452AV		PE

Set: B7.0

Doors: [B. 121B](#)

Description: EXT - MEP

3 Hinge, Full Mortise	TA2314 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Storeroom Lock	ICSL-05	626	CA
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Threshold	271A MSES25SS		PE
1 Gasketing	S88D		PE
1 Rain Guard	346C x LAR		PE
1 Sweep	3452AV		PE

Set: B8.0

Doors: [B. 101C](#), [B. 109](#), [B. 117](#), [B. 201](#), [B. 301](#), [B. 320](#)

Description: STAIR - PR - RATED

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Removable Mullion	ICLCKUL 424	PC	CA
2 Rim Exit Device, Passage	F5000 EO X SPA PAS30L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE
1 Astragal	S772D [mtg on mull]		PE

Set: B9.0

Doors: [B. 121](#)

Description: MEP PR - RATED

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
2 Flush Bolt	555 [12" / 72" AFF]	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B10.0

Doors: [B. 100E](#), [B. 100W](#), [B. 200E](#), [B. 200W](#), [B. 300E](#), [B. 300W](#)

Description: CORR DE - RATED

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
2 Fire Rated Surf Vert Rod, Exit Only	TF5000 V EO	630	CA
2 Surface Closer	4040XP.CYL. RW62A.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
2 Electromagnetic Holder	980 / 990 series	689	RF ↗
1 Gasketing	S88D		PE
1 Astragal	S772D		PE

Set: B11.0

Doors: [B. 111B](#), [B. 211B](#), [B. 311B](#)
 Description: ELEC - RATED - PANIC

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Fire Rated Rim Exit, Nightlatch	F5000 EO X SPA STR05L	630C	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B12.0

Doors: [B. 111C](#), [B. 121A](#)
 Description: ELEC - RATED - PANIC [OHS]

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Fire Rated Rim Exit, Nightlatch	F5000 EO X SPA STR05L	630C	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Gasketing	S88D		PE

Set: B13.0

Doors: [B. 122B](#), [B. 209](#), [B. 216](#), [B. 220](#), [B. 309](#), [B. 317](#)
 Description: STAIR - RATED

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Rim Exit Device, Passage	F5000 EO X SPA PAS30L	630	CA
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B14.0

Doors: [B. 103A](#), [B. 203A](#), [B. 218](#), [B. 303A](#), [B. 321A](#)
 Description: MEP - RATED

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B15.0

Doors: [B. 318](#)
 Description: LIBRARY

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Fire Rated Rim Exit, Classroom	F5000 EO L X SPA ENT00L	630	CA
1 Housing - SFIC	As required CT7D	626	
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B16.0

Doors: [B. 111D](#), [B. 211C](#), [B. 311C](#)
 Description: TELE ROOM

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
3 Silencer	608		RO

Set: B17.0

Doors: [B. 214](#), [B. 214W](#)
 Description: ENTRY

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Entrance Lock	ICSL-00	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Astragal	S772D		PE

Set: B18.0

Doors: [B. 214I](#)
 Description: BREAK

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Passage Latch	SL-30	626	CA
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: B19.0

Doors: [B. 113](#), [B. 115](#), [B. 213](#), [B. 215](#), [B. 313](#), [B. 315](#)
 Description: RESTROOM

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1 Pull Plate	BF 110 x 70C	US32D	RO

1 Push Plate	70C	US32D	RO
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B2.0

Doors: B. 100B, B. 100F
 Description: EXT PR - ENTRY

6 Hinge (heavy weight)	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1 Removable Mullion	ICLCK 424	PC	CA
1 Rim Exit Device, Classroom	5000 EO X SPA ENT00L	630	CA
1 Rim Exit Device, Dummy	5000 EO SPA DUM40L	630	CA
2 Housing - SFIC	As required CT7D	626	
2 Core (as required)	Provided by owner		
2 Surface Closer	4040XP.CYL. SCUSH.	689.	LC
2 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Threshold	271A MSES25SS		PE
1 Gasketing	303AS		PE
1 Rain Guard	346C x LAR		PE
2 Sweep	3452AV		PE
1 Astragal	S772D [mtg on mull]		PE

Set: B20.0

Doors: B. 110, B. 214E, B. 214R, B. 217H
 Description: STOR

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: B21.0

Doors: B. 111A, B. 211A, B. 311A
 Description: JAN

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	ICSL-05	626	CA
1 Core (as required)	Provided by owner		
1 Surface Closer	4040XP.CYL. RW62A.	689.	LC
1 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B22.0

Doors: B. 214C, B. 214D, B. 214F, B. 214G, B. 214H, B. 214K, B. 214L, B. 214M, B. 214N, B. 214O, B. 214P, B. 214Q, B. 214S, B. 214T, B. 214U, B. 214V
 Description: OFFICE

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Entrance Lock	ICSL-00	626	CA

1 Core (as required)	Provided by owner		
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

Set: B23.0

Doors: B. 103A, B. 103B, B. 104A, B. 104B, B. 105A, B. 105B, B. 106A, B. 106B, B. 107A, B. 107B, B. 108A, B. 108B, B. 114A, B. 114B, B. 114C, B. 116A, B. 116B, B. 116C, B. 118A, B. 118B, B. 119, B. 203, B. 204A, B. 204B, B. 205A, B. 205B, B. 206A, B. 206B, B. 207A, B. 207B, B. 208A, B. 208B, B. 210A, B. 210B, B. 303, B. 305A, B. 305B, B. 307A, B. 307B, B. 308A, B. 308B, B. 310A, B. 310B, B. 312A, B. 312B, B. 314A, B. 314B, B. 316A, B. 316B, B. 319, B. 321

Description: CLASS

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Classroom Lock	ICSL-03	626	CA
1 Core (as required)	Provided by owner		
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B24.0

Doors: B. 214A, B. 214B

Description: TOILET

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Privacy Lock	SL-20	626	CA
1 Mop Plate	K1050 4" X 1" LDW 4BE CSK	US32D	RO
1 Door Stop	409 / 446 as required	US26D	RO
1 Gasketing	S88D		PE

Set: B25.0

Doors: B. 217A, B. 217B, B. 217C, B. 217D, B. 217E, B. 217F, B. 217G

Description: CONF / STUDY

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Passage Latch	SL-30	626	CA
1 Door Stop	409 / 446 as required	US26D	RO
3 Silencer	608		RO

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Doors.
 - 2. Glazed entrances and storefronts.
 - 3. Interior glazing.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS

- A. Insulating Glass Units
- B. Manufacturer: Basis of Design: AGC America – Energy Select 23
 - 1. Description: Low E Glass.
 - a. Low E coating on #2 Surface.
 - b. Thickness: ¼ inch exterior and interior lite.
 - c. Spacer: ½ inch aluminum.
 - d. Color: Clear
- C. Acceptable Manufacturer:
 - 1. Guardian Glass: SunGuard: - SuperNatural
 - 2. Pilkington: Pilkington Solar E.
- D. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and of form and mesh pattern specified.
- E. Safety Glass: Laminated glass bonded together with polyvinyl butyral (PVB) layers.
 - 1. Level of Spall: Medium
 - 2. Thickness: 30mm

PART 3 - EXECUTION

END OF SECTION 088000

SECTION 09 2216 – NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
 - 1. Interior framing systems (e.g., supports for partition walls, furring, etc.).
 - 2. Interior suspension systems (e.g., supports for ceilings, etc.).

PART 2 - PRODUCTS

2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40 hot-dip galvanized, unless otherwise indicated.

2.2 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a.Type:Cast-in-place anchor, designed for attachment to concrete forms Post-installed, expansion anchor.
 - 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.
 - 1. Depth: 1-1/2 inches.
- E. Furring Channels (Furring Members):
 - 1. Steel Studs: ASTM C 645.
 - a.Minimum Base-Metal Thickness: As indicated on Drawings.

- b.Depth: As indicated in Drawings.
 - 2. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a.Minimum Base Metal Thickness: As indicated on Drawings.
 - 3. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
 - a.Configuration: Hat shaped.
- F. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a.Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b.Chicago Metallic Corporation; Drywall Furring System.
 - c.USG Corporation; Drywall Suspension System.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.0312 inch at fire door frames; 0.0179 (0.45-mm) for standard weight doors.
 - 2. Depth: 6 inches; and 2-1/2 inches as indicated on drawings.
- B. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.
- C. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.0179 inch.
 - 2. Depth: As indicated on Drawings 7/8 inch; 1-1/2 inches.
- D. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Hat shaped.
- E. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

PART 3 - EXECUTION

END OF SECTION 092216

SECTION 09 2900 – GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
 - 3. Abusive resistant gypsum board.

1.2 QUALITY ASSURANCE

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.1 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated. Establish Level 5 drywall finish.

2.2 INTERIOR GYPSUM BOARD

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a.American Gypsum Co.
 - b.BPB America Inc.
 - c.Lafarge North America Inc.
 - d.National Gypsum Company.
 - e.PABCO Gypsum.
 - f. Temple.
 - g.USG Corporation.
- B. Regular Type:
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
- C. Type X:
 - 1. Thickness: 5/8 inch ; ½ inch.
 - 2. Long Edges: Tapered.
- D. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
 - 1. Thickness: 1/2 inch.

2. Long Edges: Tapered.

- E. Abuse Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
1. Core: 5/8 inch, Type X.
 2. Long Edges: Tapered.

2.3 TILE BACKING PANELS

- A. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum Co.
 - b. BPB America Inc.
 - c. G-P Gypsum.
 - d. Lafarge North America Inc.
 - e. National Gypsum Company.
 - f. PABCO Gypsum.
 - g. Temple.
 - h. USG Corporation.
 - i. Core: 5/8 inch, Type X-rated assembly indicated on Drawings.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Exterior Trim: ASTM C 1047.
1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
- C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Fry Reglet Corp.
- b. Gordon, Inc.
- c. Pittcon Industries.
- 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
- 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

- E. Acoustical Sealant: As specified in Division 07 Section 079200 -Joint Sealants.

- F. Thermal Insulation: As specified in Division 07 Section 072100 - Thermal Insulation.

PART 3 - EXECUTION

END OF SECTION 092900

SECTION 093000 – TILING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Porcelain Tile
2. Tile joints.
3. Marble thresholds.
4. Accessories.

PART 2 - PRODUCTS

2.1 PORCELAIN TILE

A. MANUFACTURER: Subject to compliance with requirements provide by one of the following:

1. American Marazzi Tile, Inc.
2. American Olean Corporation
3. Dal-Tile Corporation

2.2 TERRAZZO TILE

A. MANUFACTURER

1. Wausau Terrazzo Tile
2. Terrazzoco Terrazzo Tile
3. Concord Terrazzo Company

2.3 SETTING MATERIALS AD ACCESSORIES

1. Dry-set mortar for thin set floor tile:
 - a. Acceptable products:
 1. W.R. Bonsal Co., Bonsal Premium Floor Thin Set Mortar with undiluted Bonsal B-710 SBR Thin Set Additive.
 2. Bostik Findley, Tile-Mate 710/760 with undiluted Flex-A-Lastic #447 Admixture.
 3. Custom Building Products: Flexbond Premium Flexible Bending Mortar.
2. Epoxy Grout

PART 3 - EXECUTION

END OF SECTION 093000

SECTION 095123 - ACOUSTICAL TILE CEILING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes acoustical tiles for ceilings and the following:
 - 1. Concealed suspension systems.

PART 2 - PRODUCTS

2.1 ACOUSTICAL TILES, GENERAL

- A. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration and size indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance, unless otherwise indicated.

2.2 ACOUSTICAL TILES: (GWT Standard)

- A. Manufacturer: Subject to compliance with requirements:
- B. Basis of Design: Armstrong World Industries, Inc.
 - 1. Armstrong #1713
 - 2. Armstrong #868 (Clean Room).
 - 3. Size 24 x 24.
- C. Acceptable manufacturers:
 - 1. BPB USA.
 - 2. USG Interiors, Inc.
- D. Classification: Provide tiles complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type III, mineral base with painted finish; Form 1, modular.
 - 2. Pattern: To be selected by Architect from manufacturer's standard range.
- E. Color: As selected from manufacturer's standard range.
- F. Edge/Joint Detail: Square.
- G. Thickness: 5/8 inch.
- H. Antimicrobial Treatment: Broad spectrum fungicide and bactericide.

2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL TILE CEILING

- A. Provide suspension system for extreme humidity applications. Basis of Design: USG Donn Brand All Aluminum AX Suspension System

- B. Acceptable manufacturers: Subject to compliance with requirements, provide one of the following:
1. Armstrong World Industries, Inc.;
 2. Fry Reglet Corporation.
 3. BPB USA

2.4 METAL EDGE MOLDINGS AND TRIM

- A. Products: Subject to compliance with requirements, provide one of the following:
1. Armstrong World Industries, Inc.;
 2. BPB USA;
 3. Chicago Metallic Corporation;
 4. Fry Reglet Corporation;
 5. Gordon, Inc.;
 6. USG Interiors, Inc.;

PART 3 - EXECUTION

END OF SECTION 095123

SECTION 096513 – RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Resilient base.
 2. Resilient molding accessories.

PART 2 - PRODUCTS

2.1 RESILIENT WALL BASE (RUBBER)

- A. Basis of Design: Johnsonite DC 40 (GWT Standard).
1. Color: Black.
- B. Acceptable Products subject to compliance with requirements:
1. Flexco, Inc.
 2. Roppe, Inc.
- C. Resilient Wall Base Standard: ASTM F 1861.
1. Material Requirement: Type TP (rubber, thermoplastic).
 2. Manufacturing Method: Group I (solid, homogeneous).
 3. Style: Cove base with toe at hard surface & straight flat or toeless at carpet tile.
- D. Minimum Thickness: 0.125 inch (3.2 mm).
- E. Height: 4 inches (102 mm).
- F. Lengths: Coils in manufacturer's standard length.
- G. Outside Corners: Job formed.
- H. Inside Corners: Job formed.

2.2 RESILIENT MOLDING ACCESSORY

- A. Resilient Molding Accessory:
1. Manufacturers: Subject to compliance with requirements, provide the following:
 - a. Johnsonite: Transitions

- B. Description: Reducer strip for resilient floor covering, Joiner for tile and carpet & Transition strips.
- C. Material: Rubber.
- D. Profile and Dimensions: As indicated on Drawings.
- E. Colors and Patterns: As selected by Interior Designer from manufacturers standard colors.

PART 3 - EXECUTION

END OF SECTION 096513

SECTION 096519 – RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vinyl Composition Tile.

1.2 PROJECT CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer in spaces to receive floor tile.
- B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 LUXURY VINYL TILE (GWT Standard)

- A. Manufacturer
 - 1. Basis of Design: Tarkett – Tandus Centiva
 - 2. Color: <LVT-1>Woodlot Oak Groove SSP 2322RT
 - 3. Color: <LVT-2>Woodland SSP 2328DG

2.2 VINYL COMPOSITION TILE

- A. Basis of Design: Armstrong Industries
- B. Acceptable Manufacturers':
 - 1. Johnsonite Commercial Flooring
 - 2. Carpet Express

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit floor tile and substrate conditions indicated.
 - 1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. VCT and Asphalt Tile Adhesives: Not more than 50 g/L.
- C. Floor Polish: Provide protective liquid floor polish products as recommended by manufacturer.

PART 3 - EXECUTION

END OF SECTION 096519

SECTION 09 67 23 - RESINOUS FLOORING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Resinous flooring.

1.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Koster American

1. Flake Resinous Flooring

PART 3 EXECUTION

END OF SECTION

SECTION 09 6813 - CARPET TILE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
1. Modular, solution dyed nylon carpet tile.

PART 2 - PRODUCTS

2.1 CARPET TILE (GWT Standard)

- A Basis of Design: Patcraft.
1. Style: Razzle #10118.
 2. Color: Flashy #00307.
 3. Installation Method: Random.
 4. Primary backing: Non-woven synthetic fiber.
 5. Soil Stain Protection: Yes.

PART 3 - EXECUTION

END OF SECTION 096813

SECTION 09 69 00 - ACCESS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Access flooring panels and understructure.

1.2 SYSTEM DESCRIPTION

- A. Access Flooring System: Assemblies composed of modular floor panels on pedestals with or without stringers.

PART 2 - PRODUCTS

2.1 FLOOR PANELS AND UNDERSTRUCTURE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Subject to compliance with requirements, provide product by one of the following:
 - 1. Steel-Encapsulated, Wood-Core Panel Systems:
 - a. ASM Modular Floors Inc.
 - b. Computer Environments Inc.
 - c. InterfaceAR.
 - d. Maxcess Technologies, Inc.

2.2 ACCESSORIES

- A. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.
- B. Post-Installed Anchors:
- C. Cutouts:

PART 3 - EXECUTION

END OF SECTION

SECTION 09 9123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
1. Gypsum board.
 2. Concrete masonry units (Interior)
 3. Steel- Intumescent
 4. Galvanized metal.
 5. Aluminum (not anodized or otherwise coated).
 6. Wood.

PART 2 - PRODUCTS

2.1 INTERIOR PAINT

- A. Basis of Design: Sherwin Williams.
1. Colors: As indicated on the Drawings.
- B. Acceptable Manufacturers: Products of the following manufacturers similar in type and quality are acceptable for use, subject to approval of product olist:
1. PPG Industries.
 2. Benjamin Moore Co.
 3. Duron Paint Co.
- C. Intumescent Coating (Steel)
- 1 Basis of Design: STI Firestop
- D. Colors and Gloss:
1. Colors shall match color chips selected by Architect with initial approval based on brush-out submittals and final approval based on mock-ups.
 2. Gloss, minimum, unless otherwise indicated:
 - a. Walls: Low luster or egg-shell.
 - b. Ceilings, soffits and other horizontal surfaces: Flat.

2.2 PREPARATION AND APPLICATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

- B. 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.
- C. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 - 1. Mechanical Work.
 - 2. Electrical Work.

PART 3 - EXECUTION

END OF SECTION 099123

SECTION 10 1101 - VISUAL DISPLAY BOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Markerboards.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Claridge Products

2.04 ACCESSORIES

- A. B. Marker Tray: Aluminum, manufacturer's standard profile, molded ends, concealed fasteners, same finish as frame.
- C. Mounting Brackets: Concealed.

PART 3 EXECUTION

END OF SECTION 10 1101

SECTION 10 2113 – TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes solid plastic (polymer) units as follows:
1. Toilet Enclosures: Overhead braced to structure.
 2. Urinal Screens: Floor to ceiling braced.

2.1 PRODUCTS

A. SOLID-POLYMER UNITS

1. Basis of Design: Bradley: Bradmar Partitions Series 700.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Accurate Partitions Corporation.
 - b. Ampco.
 - c. Capitol Partitions, Inc.

- B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.

1. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range of colors and patterns.

- C. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design.

- D. Brackets (Fittings):

1. Full-Height (Continuous) Type: Manufacturer's standard design; polymer or extruded aluminum where partitions abut walls.

1.2 ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard design to include coat hook, heavy-duty operating hardware and accessories.

1. Material: Chrome-plated, nonferrous, cast zinc alloy (zamac) or clear anodized aluminum.

PART 2 - EXECUTION

END OF SECTION 102113

SECTION 10 2226 - OPERABLE PARTITIONS

PART 1: GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Manually operated folding partitions.

PART 2 - PRODUCTS

2.1 MANUFACTURER

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

1. Basis of Design: Modernfold, Inc.: Acousti-Seal
 - a. Model/Series: #932.

PART 3: EXECUTION

END OF SECTION 10 2226

SECTION 10 26 00 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Wall guards.
 - 2. Wall coverings

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 CORNER GUARDS

- A. Surface-Mounted, Resilient, Plastic Corner Guards <Insert drawing designation>:
Assembly consisting of snap-on plastic cover installed over continuous retainer;
including mounting hardware; fabricated with 90- or 135-degree turn to match wall
condition.
 - 1. Basis-of-Design Product: Korogard Wall Protection Systems

2.3 IMPACT-RESISTANT WALL COVERINGS

- A. Semirigid, Impact-Resistant Sheet Wall Covering <Insert drawing designation>:
Fabricated from plastic sheet wall covering material.
 - 1. Basis-of-Design Product: Korogard Wall Protection Systems. or a comparable
product by one of the following:
 - 2. Manufacturers:
 - a. American Floor Products Co., Inc.
 - b. ARDEN Architectural Specialties, Inc.
 - c. Balco, Inc.
 - d. Construction Specialties, Inc.
 - e. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - f. Pawling Corporation.

PART 3 - EXECUTION

END OF SECTION 102600

SECTION 102800 – TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Restroom accessories.
 - 2. Shower accessories
 - 3. Under-lavatory guards.
 - 4. Custodial accessories.
- B. Unless stated in the Drawings, accessories are Owner provided, contractor installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Brass: ASTM B 19 flat products; ASTM B 16, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359-inch minimum nominal thickness.
- D. Galvanized Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.
- E. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 RESTROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Georgia Pacific
 - 2. Uline
 - 3. Bobrick
- B. Accessories:
 - 1. Hand Dryer

2. Soap Dispenser
3. Toilet Paper Dispenser
4. Toilet Cover Dispenser
5. Sanitary Napkin Disposal
6. Mirrors
7. Touchless Door Pull
8. Baby Changing station
9. Grab Bars
- 10.

2.3 JANITOR ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: The design for accessories is based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 1. A & J Washroom Accessories, Inc.
 2. American Specialties, Inc.
 3. Bobrick Washroom Equipment, Inc.
 4. Bradley Corporation.
 5. General Accessory Manufacturing Co. (GAMCO).
- C. Utility Shelf w Mop and Broom Holders: No. 8
 1. Basis-of-Design Product: Bobrick No. B-239
 2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf. With exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
 3. Hooks: Four.
 4. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
 5. Size: 34 inches long by 8 inches deep.

PART 3 - EXECUTION

END OF SECTION 102800

SECTION 104413 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire protection cabinets for the following:
 - a. Portable fire extinguishers.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fire End & Croker Corporation;
 - b. J. L. Industries, Inc., a division of Activar Construction Products Group;
 - c. Kidde Residential and Commercial Division, Subsidiary of Kidde plc;
 - d. Larsen's Manufacturing Company;
 - e. Modern Metal Products, Division of Technico Inc.;
 - f. Moon-American;
 - g. Potter Roemer LLC.
 - h. Watrous Division, American Specialties, Inc.;
- B. Cabinet Construction: 1-hour fire rated.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- thick, cold-rolled steel sheet lined with minimum 5/8-inch- thick, fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: 18-gauge stainless-steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- D. Semi-recessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semi-recessed cabinet installation.
 - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
 - 2. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- E. Cabinet Trim Material: Stainless-steel sheet, #4 finish.
- F. Door Material: Stainless-steel sheet; #4 finish.
- G. Door Style: Flush glazed insert with metal frame; Clear transparent.
- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

- I. Accessories:
 - 1. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
 - 2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
 - 3. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
 - 4. 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: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Horizontal.
 - 5. Alarm: Manufacturer's standard alarm that actuates when fire protection cabinet door is opened and that is powered by low voltage.

- J. Finishes:
 - 1. Manufacturer's standard baked-enamel paint for the following:
 - 2. Stainless Steel: No. 4.

PART 3 - EXECUTION

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.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, 2A-10B-C 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. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.
 - f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
 - h. Larsen's Manufacturing Company.
 - 2. Valves: Manufacturer's standard.
 - 3. Handles and Levers: Manufacturer's standard.
 - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type: UL-rated 4A-60B: C 10lb capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.2 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard 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:
 - 2. or comparable product by one of the following:
 - a. Amerex Corporation.
 - b. Ansul Incorporated; Tyco International Ltd.
 - c. Badger Fire Protection; a Kidde company.
 - d. Buckeye Fire Equipment Company.
 - e. Fire End & Croker Corporation.

- f. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - g. Larsen's Manufacturing Company.
 - h. Potter Roemer LLC.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
- 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Horizontal.

PART 3 - EXECUTION

END OF SECTION 104416

SECTION 10 7316- CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Acousti Roof Deck.

1.2 METAL CANOPIES

- A. Basis of Design: Epic Metals Corp
 - 1. Style: Toris A

PART 3 EXECUTION

END OF SECTION 107300

SECTION 108213 – EXTERIOR GRILLES AND SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pre-formed acrylic panel for enclosing roof top mechanical equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: CityScapes Incorporated – Envisor Screening System

1. Panel Style: Acrylicap Louver.
2. Design: Perimeter Wall.
3. Material: Pre-treated ABS.

B. Acceptable Manufacturers: Subject to compliance with requirements:

1. RoofScreen Equipment Screen System
2. PalmShield Louvers and Screening.

PART 3 - EXECUTION

END OF SECTION 108213

SECTION 11 5300 LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: All items listed below shall be Contractor Furnished Contractor Installed.
 - 1. Under-counter glassware washing equipment.

- B. Related Sections:
 - 1. Division 1 Section "Summary" for requirements associated with Owner furnished products.
 - 2. Division 5 Section "Metal Fabrications" for support of ceiling mounted laboratory equipment.
 - 3. Division 9 Section "Non-Structural Metal Framing" for reinforcements in metal framed gypsum board partitions for anchoring equipment.
 - 4. Division 22, 23, 26, and 27 Sections for plumbing, mechanical, electrical, and communications services and connections for complete equipment installation.
 - 5. Division 23 Section "Testing, Adjusting and Balancing" for testing of equipment connected to exhaust system.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Laboratory equipment, including attachment to other work, shall withstand the effects of earthquake motions determined according to the applicable Building Code requirements.
 - 1. Design earthquake spectral response acceleration, short period (Sds) for Project: Refer to Structural documents.
 - 2. Component Importance Factor: **1.5**

- B. Biological Safety Cabinet Ventilation Rate: NSF Class II, Type **A2 canopy exhaust, B1 and B2** biological safety cabinets shall be designed to operate at nominal face velocity, total exhaust ventilation rates and containment requirements indicated. Refer to Mechanical Drawings for maximum allowable exhaust ventilation rates.

1.3 SUBMITTALS

- A. Submit complete submittal package of product data, shop drawings, samples and informational submittals. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.

- B. Action Submittals:
 - 1. Product Data: For each type of product indicated. Include the following:

- a. Manufacturer model number.
 - b. Accessories and components that will be included for Project.
 - c. Clearance requirements for access and maintenance.
 - d. Utility service connections for water, drainage, power, and fuel; include roughing-in dimensions.
 - e. Key equipment using same designations as indicated on Drawings
2. LEED Submittals:
- a. Certificates for Credit MR4.1 and MR4.2: For products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
 - 1) Include statement indicating costs for products having recycled content.
3. Shop Drawings: For each type of product requiring attachment to other work. Include plans, elevations, sections, details, roughing-in dimensions, weights, loads, service clearances, utility service requirements, seismic restraint, and attachments to other work. Show relationship to adjoining work.
- a. For overhead supported equipment, show relationship to structural members to which equipment is attached, suspended ceilings, mechanical, plumbing, fire protection and electrical features, and other above ceiling mounted building components.
 - b. Wiring Diagrams: For power, signal, and control wiring.
 - c. Key equipment using same designations as indicated on Drawings
4. Samples: For each exposed product and for each material requiring color selection.
- C. Informational Submittals:
1. Seismic Design Calculations: For seismic design of laboratory equipment including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Product Certificates: For each type of product, from manufacturer certifying that products furnished comply with requirements.
 3. Source quality-control reports.
 4. Field quality-control reports.
- D. Project Closeout Submittals:
1. Operation and Maintenance Data: For products to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section " Operation and Maintenance Data," include the following:
 - a. Product Schedule: For each equipment item, include the following:
 - 1) Designation indicated on Drawings.
 - 2) Manufacturer's name and model number.
 - 3) List of factory-authorized service agencies including addresses and telephone numbers.

1.4 QUALITY ASSURANCE

- A. [Regulatory Requirements: Where biological safety cabinets are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities," ICC/ANSI A117.1 and the applicable Building Code.]
- B. Installer Qualifications: Experienced installers' who have completed installation of products similar to that indicated for this Project and whose work has resulted in a record of successful in-service performance. Where required by product manufacturer, installers' shall be authorized, trained and approved by equipment manufacturer.
- C. Source Limitations: Obtain each type of laboratory equipment of the same kind or function through a single source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.
- F. Product Designations: Drawings or Specifications indicate sizes and configurations of laboratory equipment by referencing designated manufacturer's model numbers. Other manufacturers' laboratory equipment of similar sizes, configurations and complying with the Specifications may be considered. Refer to Division 01 Section "Product Requirements."
- G. [Biological Safety Cabinet Product Standard: Listed by NSF International as complying with NSF/ANSI-49 Class II Biosafety Cabinetry.]
- H. Ice Machine Product Standard: Listed by NSF International as complying with NSF/ANSI-12 Automatic Ice Making Equipment.
- I. [Safety Glass: Products complying with testing requirements in 16 CFR 1201 for Category II materials.]
 - 1. [Permanently mark safety glass with certification label of Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.]
- J. [ASME Compliance: Fabricate and label sterilizers to comply with ASME Boiler and Pressure Vessel Code.]
- K. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install products until building is enclosed and weathertight, utility roughing-in and wet work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of openings and construction contiguous with products by field measurements before fabrication.

1. Established Dimensions: Where field dimensions cannot be made without delaying the Work, establish dimensions and proceed with fabrication without field dimensions. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.6 COORDINATION

- A. Coordinate product layout and installation with other work, including layout and installation of framing, reinforcement required to support product, plumbing, fire protection, mechanical, electrical, and communications components.
- B. Coordinate locations and requirements of utility service connections.
- C. Coordinate sizes, locations, and requirements of the following:
 1. Overhead equipment supports and ceilings.
 2. Floor areas with positive slopes to drains.
 3. Floor sinks and drains serving equipment.

PART 2 - PRODUCTS

2.1 UNDER-COUNTER GLASSWARE WASHING EQUIPMENT

- A. Glassware Washer Type-A, Undercounter:
 1. Products:
 - a. Labconco Corporation; Product – Flask-Scrubber Laboratory Glassware Washer, Model 4420321.
 - b. Lancer USA, Inc.; Product – Lancer 815LX Laboratory Glassware Washer.
 - c. Miele USA, Inc.; Product – Miele G 7893 Compact Washer with Integrated Forced-Air Drying.
 - d. Steris Corporation; Product – Reliance 100 Series Laboratory Glassware Washer, Model 100LS.
 2. Description: Fully automatic undercounter washer with electronic programmable microprocessor controls for pre-wash, wash, rinse and pure water rinse.
 - a. Dimensions:
 - 1) External: Nominal 33-inch H x 24-inch W x 28-inch D
 - 2) Internal Chamber: Nominal 20-inch H x 22-inch W x 21-inch D.
 - 3) Loading Height: Nominal 12 inches or less.
 - b. Configuration:
 - 1) Washer Chamber Load Area: 2 wash levels.
 - 2) Cycles: Microprocessor controls; pre-programmed cycles and user-defined cycles; pre-wash, wash, running water rinse 1, acid rinse, running water rinse 2, pure water rinse-cold, pure water rinse-hot cycle capabilities.
 - 3) Steam generator.

c. Features:

- 1) Body, Door and Washing Chamber: Interior Type 304 stainless steel; exterior Type 304 stainless steel.
- 2) Drop-down door; counter-balanced, insulated; door/cycle interlock.
- 3) Fully extendable, load bearing arms.
- 4) Spray system, rotary type in top and bottom chamber; Type-304 stainless; easily disassembled for cleaning and maintenance
- 5) System Wash Levels: 1 to 2 levels; rack actuated automatic manifold connections when door is closed; rack accessories independent and easily removable at all levels.
- 6) Main wash pump.
- 7) Filter Systems: Stainless steel filters protecting re-circulation pump and drain pumps from debris; easily removable. Filters on incoming water lines.
- 8) Manual-fill detergent dispenser for liquid or powder detergents
- 9) Manual-fill rinse aid solution dispenser.
- 10) Wash solution heating system.
- 11) Electronic thermostat; independent selection of pre-wash, wash and final rinse temperatures.
- 12) Touch-pan control panel with LED display.
- 13) System monitoring with audible and visual alarms for hot glass, water low, water high, overflow, liquid detergent low, rinse aid low, drain fail, low temperature.
- 14) Forced air drying.
- 15) Leveling feet.
- 16) Hoses for water supply lines and washer drain hoses.

d. Optional Features: Include the following:

- 1) Drain discharge cool down; effluent cooled to less than 140-deg F or as otherwise required by the applicable Plumbing Code, before discharge to building waste system.
- 2) Low pressure valve kit to provide proper water pressure for purified water supply.

e. Accessories:

- 1) Lower spindle rack (36) detachable spindles, (18) glassware holder, (36) height adjustable clips and (10) additional interchangeable small spindles.
- 2) Upper standard rack.

Electrical Service: Equip unit for connection to service indicated on Drawings.

2.2 SOURCE QUALITY CONTROL

A. Biological Safety Cabinet Factory Test: Test and inspect each biological safety cabinet according to NSF Standard #49 "Performance Tests" article. Provide testing facilities, instruments, equipment and materials needed for test.

1. Where UV germicidal light is specified, provide documentation that installation does not affect performance of biological safety cabinet.
2. Prepare source quality control test reports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb, according to manufacturer's written instructions.
 - 1. Verify utility services are in required locations and are ready for use before installation of equipment.
 - 2. Complete equipment assembly where field assembly is required.
 - 3. Connect equipment to utilities.
- B. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and requirements of authorities having jurisdiction.
- C. Built-in Equipment: Place units in final location after finishes have been completed in each area. Securely anchor to supporting substrate with concealed fasteners where possible. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- D. Freestanding and Countertop Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.2 FIELD QUALITY CONTROL

- A. Manufacturers' Field Service: Engage factory-authorized service representatives' to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Perform tests and inspections:
 - 1. Perform visual, mechanical and electrical inspection and testing for each product according to manufacturers' written recommendations. Certify compliance with each manufacturer's equipment-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
 - 5. After making corrections, retest products that failed to perform.
 - 6. Where equipment is connected to exhaust system, adjust equipment, building exhaust fans, and building HVAC system, or replace equipment and make other corrections until tested equipment performs as specified.
 - 7. Coordinate field testing of equipment connected to exhaust system with requirements of Division 23 Section "Testing, Adjusting and Balancing for HVAC."
- C. Commissioning: Refer to Division 01 Sections for commissioning requirements.
- D. A product will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.3 CLEANING AND PROTECTION

- A. After completing installation of equipment, repair damaged finishes.
- B. Clean and adjust equipment as required to produce ready-for-use condition. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by manufacturer.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- D. Protect equipment from damage during remainder of the construction period.

3.4 DEMONSTRATION

- A. Engage factory-authorized equipment service representatives' to train Owner's maintenance personnel to adjust, operate, and maintain products.

END OF SECTION

SECTION 11 5313 LABORATORY FUME HOODS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Bench-top laboratory fume hoods.
 2. Work surfaces within fume hoods.
 3. Laboratory sinks and cup sinks within fume hoods.
 4. Laboratory water, gas and electrical service fittings within fume hoods.
 5. Piping and wiring within fume hoods for service fittings, light fixtures, fan switches, and other electrical devices included with fume hoods.

1.2 PERFORMANCE REQUIREMENTS

- A. Containment: Tested according to ASHRAE 110 as modified below at a release rate of **4.0 L/min**.
1. Average Face Velocity:
 - a. Vertical Rising Sash: **100 fpm (0.51 m/s)** with sash at operating height of **18 inches (457 mm)**; **60 fpm (0.30 m/s)** or less with sash at full open position for set-up, not less than **25 inches (635 mm)** above work surface.
 2. As-Manufactured (AM) Rating: Not more than AM 0.05 (0.05 ppm).
 3. As-Installed (AI) Rating: Not more than AI 0.10 (0.10 ppm).

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For laboratory fume hoods. Include plans, elevations, sections, details, and attachments to other work.
1. Indicate details for anchoring fume hoods to permanent building construction including locations of blocking and other supports
 2. Indicate locations and types of service fittings together with associated service supply connection required.
 3. Indicate duct connections, electrical connections, and locations of access panels.
 4. Include roughing-in information for mechanical, plumbing, and electrical connections.
- C. Samples: For fume hood exterior finishes interior lining and work top material, in manufacturer's standard sizes if different from casework finishes.
- D. Product Test Reports: Showing compliance with specified performance requirements for as-manufactured containment and static pressure loss based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency.
- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Laboratory fume hoods obtained from same source from same manufacturer as laboratory casework.
 - 1. Obtain base cabinets below fume hoods from fume hood manufacturer.
- B. Product Standard: SEFA 1 and UL listed and labeled for compliance with UL 1805.
- C. Safety Glass: 16 CFR 1201 for Category II materials.
- D. Electrical Components, Devices and Accessories: Listed and labeled per NFPA 70.

1.5 EXTRA MATERIALS

- A. Furnish complete touchup kit for each type and color of fume hood finish provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged fume hood finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kewaunee Scientific Corporation; www.kewaunee.com
 - b. Mott Manufacturing Ltd.; www.mott.ca
 - c. Air Master Systems Corporation, www.airmastersystems.com
 - d. Labconco; www.labconco.com
- B. Product: Basis of design: Manufacturer: Kewaunee Scientific Corporation
 - 1. High Performance Low velocity Fume hood:
 - a. Model : Supreme Air LV05 Hood
- C. Fume hood Schedule: Refer to Laboratory drawings for size and utilities required.

2.2 MATERIALS

- A. Steel Materials:
 - 1. Recycled Content: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25-percent.
 - 2. Steel Sheet: Cold-rolled commercial steel, ASTM A 1008/A 1008M.
- B. Glass-Fiber Reinforced Polyester: Polyester laminate with chemical-resistant gel coat; flame spread of 25 or less per ASTM 84.
- C. Epoxy Materials: Factory-molded. Comply with requirements of Division 12 Section "Laboratory Casework."

- D. Glass: Clear, laminated glass complying with ASTM C 1172, Kind LT, Condition A, Type I, Class I, Quality-Q3 with clear, polyvinyl butyral interlayer.

Fasteners: Stainless steel where exposed to fumes.

2.3 FABRICATION

A. Fume Hoods:

1. Constant Volume Exhaust System
2. Face-Velocity Variation: +/- 10 percent of average face velocity.
3. General: Assemble fume hoods in factory to greatest extent possible. Disassemble fume hoods only as necessary for shipping and handling limitations. Fume hoods shall be capable of being partly disassembled as necessary to permit movement through a 35-by-79-inch (889-by-2007-mm) door opening.
4. Steel Exterior: Fabricate from steel sheet, not less than 0.0478 inch (1.2 mm) thick, with component parts screwed together to allow removal of end panels, front fascia, and airfoil and to allow access to plumbing lines and service fittings. Apply chemical-resistant finish to interior and exterior surfaces of component parts before assembly.
5. Ends: Fabricate with double-wall end panels without projecting corner posts or other obstructions to interfere with smooth, even airflow. Close area between double walls at front of fume hood and as needed to house sash counterbalance weights, utility lines, and remote-control valves.
6. Splay top and sides of face opening to provide an aerodynamic shape to ensure smooth, even flow of air into fume hood.
7. Interior Lining:
 - a. White Polyresin: Press-molded, heat-converted catalyzed glass polyester sheet of white polyresin.
 - b. Liner to have a "O" flame spread per ASTM E84.
 - c. Fasten liner material to a 16 gauge x 1 1/4 inch U-channel frame, continuous along each edge where different liner panels are joined. Do not use L-shaped discontinuous angles for joining liner segments.

- B. Lining Assembly: Unless otherwise indicated, assemble with stainless-steel fasteners or epoxy adhesive, concealed where possible at glass-fiber reinforced liner. Seal joints by filling with chemical-resistant sealant during assembly.

1. Fasten lining components to a rigid frame assembly fabricated from steel and to which exterior panels are attached.
2. Punch fume hood lining side panels to receive service fittings and remote controls. Provide removable plug buttons for holes not used for indicated fittings.
3. Interior Access Panels: Provide interior gasketed access panels at end wall panels of fume hoods for access to end wall utility services.

- C. Exhaust Plenum: Full width of fume hood and with adequate volume to provide uniform airflow from hood, of same material as hood lining, and with duct stub for exhaust connection.

1. Duct-Stub Material: stainless steel
2. Bypass Grilles/Openings: Provide at bypass openings of fume hoods.
3. Fume Hood Sash:
 - a. Unframed vertical rising sash.
4. Combination vertical rising/horizontal sliding sash.
5. Sash Opening Height:
 - 1) Full Open, 27 to 30 inches (685 to 762 mm); 36 inch (914 mm) high where indicated.

- 2) Bench-Top Accessible Fume Hoods: 36 inch (914 mm) where indicated.
 6. Sash Glazing: Laminated safety glass.
 7. Sash Closing Features:
 - a. Automatic Sash Closing Operator (Vertical Rising Sash): Microprocessor controlled, electric motor operated automatic sash operator with infrared movement detector, infrared sash safety barrier/stop, with adjustable delay timer for automatic vertical sash closing when hood is not in use.
 8. Light Fixtures: Vapor-proof, two tube, rapid-start fluorescent light fixture with lamps; laminated glass lens sealed into hood. Lamps replaceable from outside of fume hood.
- D. Base Cabinets: Comply with requirements of Division 12 Section "Laboratory Casework."
- E. Work Surfaces: Comply with requirements of Division 12 Section "Laboratory Casework" and the following:
1. Epoxy Countertops: Raised (marine) edge; 1-1/4 inch (32 mm) thick at raised edge.
 - a. Floor Mounted Fume Hoods: 1 inch (25 mm) thick at raised edge.
- F. Laboratory Sinks: Comply with requirements of Division 12 Section "Laboratory Casework;" match work surface material.
- G. Fillers and Closures: Same material and finish as fume hood exterior.
1. Filler Strips: As needed to close space between fume hoods and adjoining construction.
 2. Ceiling Closures: Where indicated to enclose space above fume hoods at front and sides and extending from top of hood to ceiling. Provide removable panel or access panel at front to provide access to top of hood and light fixtures.
 3. Finished Back: Provide where back of fume hood is exposed to view.
- H. Pre-Piping: Comply with requirements of Division 22 and 23 Sections for piping materials for each type of service. Pre-pipe to 6" above top of hood at back of fume hood.
- I. Pre-Wiring: Comply with requirements of Division 26 Sections for electrical power wiring, conduit and box materials. Pre-wire electrical services to accessible junction boxes on top of fume hood.
- J. Finishes:
1. Metal Finish: Color as selected by Architect Two coat, chemical resistant baked-on finish. Comply with SEFA-8M; no more than four Level 3 conditions and within range for each chemical reagent.
 2. Stainless Steel Finish: Directional satin, No. 4 finish.
- K. Accessories:
1. Service Fittings: Comply with requirements in Division 12 Section "Laboratory Casework."
 2. Fume Hood Controller: Airflow indicator, airflow alarm and sash alarms; audible and visual alarms with silence, test and reset switches; furnished by Division 23 Section. Provide factory cutouts for field installation
 3. Sash Stops: Sash stops to limit hood opening to sash operating height.
 4. Labels: Chemical resistant plastic identifying operating height and face velocity; other labels as required by manufacturer.
 5. Bypass Blank-off Panels: As required to adjust bypass area to balance air volume and provide design face velocity with sash at operating height.

6. Sash Stops: Provide fume hoods with sash stops to limit hood opening to sash operating height indicated in "Performance Requirements" Article. Sash stops can be manually released to open sash fully for cleaning fume hood and for placing large apparatus within fume hood.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install fume hoods level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels, but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Comply with requirements in Division 12 Section "Laboratory Casework" for installing fume hood base cabinets, work tops, and sinks.

3.2 SOURCE QUALITY CONTROL

- A. Demonstrate fume hood performance before shipping; test one fume hood of each type required according to ASHRAE 110 as modified in "Performance Requirements" Article.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency:-Contractor engaged-
- B. Field test installed fume hoods according to ASHRAE 110-1995 as modified in "Performance Requirements" Article to verify compliance with performance requirements.
 1. Adjust fume hoods, hood exhaust fans, and building's HVAC system, or replace hoods and make other corrections until tested hoods perform as specified.
 2. After making corrections, retest fume hoods that failed to perform as specified.

END OF SECTION 11 5313

SECTION 122113 - HORIZONTAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Horizontal louver blinds with aluminum slats.

PART 2 - PRODUCTS

2.1 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

- A. Products: Subject to compliance with requirements, provide one of the following:
1. Hunter Douglas; .
 2. Levolor, a Newell Rubbermaid Company;
 3. Springs Window Fashions Division, Inc.;

PART 3 - EXECUTION

END OF SECTION 122113

SECTION 12 2513 – MOTORIZED ROLLER SHADES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrically operated, sunscreen and blackout roller shades. Include local, group and master motor control systems for shade operation with addressable, encoded, electronic drive units (EDU) including the following:
 - 1. Wireless daylight sensors (WDS).
 - 2. Wireless controllers (MWC).
 - 3. Network interface (MNI).
 - 4. Turn-Key Single-Source Responsibility for Motorized Interior Roller Shades: To control the responsibility for performance of motorized roller shade systems, assign the design, engineering, and installation of motorized roller shade systems, motors, controls, and low voltage electrical control wiring specified in this Section to a single manufacturer and their authorized installer/dealer. Refer to additional requirements specified in this Section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer: Mecho,
- B. MechoShade Electro 1 with WhisperShade IQ2 Electronic Drive Unit.

END OF SECTION 12 2513

SECTION 12 3553 LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Wood laboratory casework.
 2. Shelving.
 3. Tables
 4. Casework hardware and accessories.
 5. Laboratory work surfaces.
 6. Laboratory sinks.
 7. Casework accessories.
 8. Water, laboratory gas, safety and electrical service fittings.

1.2 QUALITY ASSURANCE

- A. Casework Product Standard: SEFA 8 for cabinet materials indicated.
- B. Work Surface Product Standard: SEFA 3 work surfaces indicated.
- C. Wood Countertop Standard: AWI's "Architectural Woodwork Quality Standards."
- D. Flammable Liquid Storage Cabinets: Complying with NFPA 30; UL listed; FM approved..
- E. Hazardous Material Storage Cabinets: Complying with NFPA 30; UL listed; FM approved..
- F. Electrical Components, Devices and Accessories: Listed and labeled as defined by NFPA 70.

1.3 DESCRIPTION OF WORK:

- A. Extent of laboratory casework and fixtures is shown on drawings and as specified herein.
- B. Work includes the fabrication and installation of wood and metal laboratory casework components consisting of: base cabinets, mobile base cabinets, wall cabinets, storage cabinets, tables, cabinet tops, lab type sinks and mechanical service fixtures, cabinet under-structures for fume hoods, custom casework assemblies, lab type shelf units, and other casework units as indicated on the drawing. Fume Hoods are specified in Section 115313.
- C. Piped utility service fixtures as denoted in Part 2 are supplied (loose) by this Section. Installation of service fixtures and connection to piped utilities is specified in Division 22.
- D. Waste Lines and traps are to be furnished and under Division 22. All sinks provided by this Section are listed in Part 2 of this section. These sinks are provided with a tailpiece. Piping and fittings downstream from tailpiece are furnished and installed under the requirements of Division 15.

- E. All electrical devices, wiring, electrical raceway products and ground connections are, unless noted otherwise, provided and installed by the General Contractor as specified in Division 26. Providing cutouts in laboratory casework for the installation of electrical devices is the responsibility of this Section.
- F. Base molding is specified in Division 9.
- G. In-wall blocking and supports for wall hung casework are specified in Division 6. Coordinate the locations of in-wall blocking using the shop drawings provided by this Section.
- H. Sealants are specified under Division 7. Sealants which come into contact with any materials specified in 12 35 53 are to be installed under this Section.
- I. Related Sections:
 - 1. General Requirements, Division 1.
 - 2. Section 11 - Laboratory Fume Hoods.
 - 3. Division 22-25 - Mechanical/Plumbing,
 - 4. Division 26 - Electrical

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's data and installation instructions for each type of laboratory casework unit, fixtures, and accessories.
- B. Finish: Include independent laboratory certification that applied finish complies with specified chemical and physical resistance requirements.
- C. Performance Requirements: Submit independent laboratory certification that casework complies with the specified performance requirements.
- D. Samples: Samples will be retained by the A/E. Samples shall be delivered, at no cost to the A/E. Furnish the following:
 - 1. One 6" x 6" sample of all finished casework materials specified, both wood and metal. This sample is for color / stain / wood grain / paint quality verification and will form the basis of acceptance or rejection of items for installation. Wood samples should be sufficient to show actual range of colors and grains that will be provided. Wood samples must also show range of anticipated imperfections to establish what will constitute "noticeable" (unacceptable) and un-noticeable (acceptable) imperfections.
 - 2. One 4" x 4" sample of all counter top materials specified.
 - 3. One of each specified mechanical service fitting, electrical fitting, drawer / door lock, door / drawer pull, door hinge, other casework accessories, and signage for flammable storage and acid storage cabinets.
- E. Shop drawings: for laboratory casework show plans, elevations, ends, cross-sections, service run spaces, location and type of all service fixtures. Show details and location of anchorage and fitting to floors, walls, and base. Include layout of units with relation to surrounding walls, doors, windows, in-wall electrical outlets and other building components. Fume hood elevations are to be included with casework elevations. Coordinate shop drawings with other trades involved. Indicate all in-wall blocking and rough-in requirements for coordination with other trades. Show locations of countertop joints. Shop drawings that do not comply with this list of features will be rejected without further review.

1.5 QUALITY ASSURANCE:

- A. Single Source Responsibility: Provide laboratory casework with tops, sinks, and service fixtures, manufactured or furnished by a single laboratory casework company for single responsibility. Laboratory fume hoods specified in Section 115313 must be fully integrated with casework as shown on drawings and should be furnished by the same laboratory casework company.
- B. Provide written warranty signed by the manufacturer guaranteeing to correct failures in products which occur within the warranty period indicated below, without reducing or otherwise limiting any other rights to correction which the Owner may have under the contract documents. Correction may include repair or replacement. Correct failures which occur within the following warranty period(s) after Final Acceptance:
1. All components: 3 years
 2. Metal cabinets: 3 years
- C. Chemical and Physical Resistance of Finish: Submit an independent testing laboratory report certifying that the exterior finish of laboratory casework is capable of withstanding following tests, with no change, or slight change of gloss, slight discoloration, or slight temporary softening of film with no loss of adhesion and no loss of film protection.
1. Acids: Not less than 10 drops (0.5 cc) applied to finish of horizontal surface, covered with watch glass concave side down for 60 minutes, then washed and dried.
 - 50% Acetic Acid
 - 98% Acetic Acid
 - 20% Hydrochloric Acid
 - 37% Hydrochloric Acid
 - 10% Nitric Acid
 - 30% Nitric Acid
 - 50% Phosphoric Acid
 - 75% Phosphoric Acid
 - 25% Sulfuric Acid
 - 70% Sulfuric Acid
 2. Solvent: Not less than 10 drops (0.5 cc) applied to finish of horizontal surface, covered with watch glass concave side down for 60 minutes, then washed and dried.
 - Acetone
 - Benzene
 - Butyl Alcohol
 - Carbon Tetrachloride
 - Ethyl Acetate
 - Ethyl Alcohol
 - Ethyl Ether
 - Formaldehyde, 37%
 - Furfural
 - Gasoline
 - Glycerin
 - Kerosene
 - Methyl Alcohol
 - Methyl Ethyl Ketone
 - Naphtha
 - Toluene
 - Xylene
 3. Bases and Salts: Not less than 5 drops (0.25 cc) applied to finish of horizontal surface, covered with watch glass convex side down for 60 minutes, then washed and dried.
 - 10% Sodium Hydroxide
 - 40% Sodium Hydroxide

28% Ammonium Hydroxide
40% Potassium Hydroxide
10% Potassium Hydroxide
Saturated Zinc Chloride
Saturated Sodium Chloride
Saturated Sodium Sulfide
Saturated Sodium Carbonate

4. Moisture Resistance: No visible effect when finish surface exposed to the following:
 - a. Hot water at a temperature of 190 degrees F (91 degrees C) to 205 degrees F (96 degrees C) trickled down surface at 45 degree angle for 5 minutes.
 - b. Constant Moisture using a 2" x 3" x 1" cellulose sponge, soaked with water, in contact with surface for 100 hours.
5. Cold Crack: No effect when subjected to 10 cycles of temperature change from 20 degrees F (14 degrees C) for 60 minutes to 125 degrees F (52 degrees C) for 60 minutes.
6. Adhesion and Flexibility: No peeling or cracking or exposure of metal when metal is bent 180 degrees over a 1/2" diameter mandrel.
7. Adhesion: Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1/16" apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197 68, "Standard Method of Test for Adhesion of Organic Coatings".
8. Hardness: The finish shall have a hardness of 4-H using the pencil hardness test.
9. All casework construction and performance characteristics shall be in full compliance with minimum SEFA 8 standards. At the owner's request, independent, third part testing must be submitted validating compliance and adheres to the architectural specifications.

1.6 REFERENCE STANDARDS

- A. All casework, work surface and service fixture construction and performance characteristics shall be in full compliance with SEFA (Scientific Equipment and Furniture Association) standards. At the owner's request, independent, third party testing must be submitted validating compliance and adheres to the architectural specifications.
 1. SEFA 2.3 – Installation of Scientific Laboratory Furniture and Equipment.
 2. SEFA 3 – Work Surface.
 3. SEFA 7 – Laboratory and Hospital Fixtures
 4. SEFA 8 – Laboratory Furniture

1.7 DEFINITIONS

- A. Broom Clean: a condition in an interior area in which surface debris has been removed by dry methods.
- B. Mechanical Service Fittings and Fixtures: Service fittings include gas, air, vacuum and special gas petcocks, valves and turrets; lab type hot and cold water faucets; pure water faucets, remote control valves for fume hoods; vacuum breakers; deck mounted eye-washers; laboratory sinks, and cup sinks.

- C. Rough-In Point: Individual or common supply of mechanical, electrical, and heating, ventilating and air conditioning (HVAC) through wall, floor, or ceiling, generally located within the utility umbilical, equipment chase, or service space behind cabinets.
- D. Related Equipment. Items not generally manufactured by Casework Contractor but furnished and installed as part of Casework Contractor's contract.

1.8 PROJECT CONDITIONS

- A. Building Finish. Upon delivery of casework to the job site, it must be possible to allow complete distribution and commencement of physical installation in the rooms where the casework is designated to be installed. In order to ensure an orderly installation and to avoid damage to finished casework, the following list of building conditions shall be completed by the Constructor prior to installation of casework and fixtures (other than initial rough-in). The Owner and Casework Contractor shall conduct a joint review of the site prior to installation to confirm that the following requirements are met.
 - 1. Floors shall be level to within the tolerances specified (in Divisions 9) to provide an even surface for installation of furniture and equipment. Final floor finish shall be completed prior to casework installation. Provide backing support for base molding for any gaps over 1/4 inch between casework and flooring (i.e. close gap between bottom of cabinet and floor).
 - 2. Wall systems shall be completely installed and be plumb for installation of wall cabinets. All blocking and supports for wall cabinets shall be installed. Wall system finish shall be complete including final painting.
 - 3. The ceiling system shall be in place including suspension grid and ceiling panels except at fume hoods and utility umbilical drops at island benches. The intention of this is to eliminate overhead work by other trades once finished casework is installed.
 - 4. Branch electrical circuits, including grounding conductors, shall be in place.
 - 5. HVAC grilles and sprinkler heads shall be installed.
 - 6. Overhead electrical fixtures shall be installed and connected. Provide adequate lighting for installation of casework.
 - 7. Overhead mechanical lines shall be tested for leaks before finished casework is installed in any area.
 - 8. Where mechanical, electrical and HVAC service lines will be behind or under casework, service access or stubs shall have been installed at the appropriate rough-in point.
 - 9. Service lines for water, gas, vacuum, and special gases shall be flushed clean of dirt and chips, capped and tested for leaks prior to the connection of service fittings.
 - 10. Environmental Conditions. The building shall be closed to the weather. Exterior envelope including roofing, wall systems, exterior glazing, paneling and doors shall be installed to protect casework from the elements and to provide security for casework delivered to the job site. Corridors shall be closed by either permanent or temporary methods.
 - 11. No standing water shall be evident on the floor. Water producing operations such as masonry, and plaster shall be completed and cured prior to casework installation.
 - 12. Rooms in which laboratory casework is to be installed shall be broom clean.
 - 13. During cold weather provide temporary or permanent heat to maintain ambient room temperatures at 70 degrees F with relative humidity of 50% or less.
- B. Maintain final design temperature and humidity in areas where casework is installed.
- C. Fit casework to actual construction. If it is not possible or practical, to take field measurements before fabricating, provide adequate installation tolerances and scribe or trim to fit.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver laboratory casework only after wet operations in building are completed.
- B. Laboratory casework shall be stored only in a ventilated place, protected from the weather, with relative humidity therein of 50% or less at 70 degrees F.
- C. Protect finished surfaces from soiling and damage during handling and installation. Keep covered and secured with polyethylene film or other protective covering and label with large, bold lettering "DO NOT STAND ON THIS SURFACE". Reusable shipping blankets are preferred to reduce the amount of construction waste.
- D. In the case of high value items, such as service fittings, that may be shipped to the job site on larger projects and used over the course of several months installation, a secure, locked storage area shall be provided by the General Contractor to the Installer for use to safeguard this equipment at the job site prior to distribution to the proper trades for installation.
- E. Laboratory casework and counters are not to be used as workbenches or work platforms for any portion of the work by any trade. Furniture and casework, as installed, is considered to be finished equipment and shall be protected from damage by all trades. Replace or repair any damaged casework or counter materials. The A/E shall be the sole judge of "repair or replace" options.
- F. Painting and Other Finishing Trades. Perform minor wall touch-up around casework. Seal between casework and wall. Protect installed laboratory casework and equipment, especially the laboratory work surface, from debris, paint and damage in the course of the construction sequence.
- G. Mechanical and Electrical Trades. Where access is required through items of laboratory casework, it shall be the mechanical or electrical contractors' responsibility to remove said access panels, drawers, etc., where they occur, make their connections and replace such access panels, drawers, etc. at their own expense.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Laboratory Casework, Shelving, Service Carrier, and service panels Basis-of-Design Manufacturer: Kewaunee Scientific Corporation; Mott Manufacturing,
- B. Epoxy Resin Manufacturer: Subject to compliance with requirements, provide products by one of the following: Kemresin, Durcon, Inc, Prime Industries, Inc.
- C. Water, Laboratory Gas and Electrical Service Fittings Basis-of-Design Products: Subject to compliance with requirements, provide Water Saver Faucet Co. products

2.2 MATERIALS

A. Steel Materials:

1. Recycled Content of Steel Products Provide products with average recycled content of steel products such that post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25-percent.
2. Steel Sheet: Cold-rolled, commercial steel sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications
3. Stainless Steel: ASTM A 666/A 666M.
 - a. Cabinets: Type 304.
 - b. Countertops: Type 316L indicated

B. Wood Materials:

1. Wood Species and Cut for Transparent Finish: Walnut, plain sliced, Stain: Clear. Basis of design Mott manufacturing, Mott:7074.
2. Certified Wood Materials: Provide cabinets with not less than 70 percent of wood products obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship.
3. Recycled Content of Medium-Density Fiberboard and Particleboard: Products with average recycled content so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 70 percent.
4. Adhesives: Do not use adhesives that contain Urea-formaldehyde
5. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
6. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated, made without urea formaldehyde.
7. Medium Density Fiberboard (MDF): ANSI A208.2, Grade 130, made with binder containing no urea formaldehyde.
8. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde
9. Hardboard: AHA A135.4, Class 1 Tempered.

C. Solid Composite Materials: Factory-molded, modified epoxy-resin formulation with smooth, non-specular finish.

1. Physical Properties:
 - a. Modulus of elasticity: 1,500,000 psi minimum
 - b. Shear strength: 2000psi minimum.
 - c. Compressive Strength: 24,000psi minimum
 - d. Weight: 93 lbs. per cubic foot maximum
 - e. Heat Distortion Point: Flame spread (ASTM E-84): Class 1A (25).
2. Chemical Resistance: Not more than four Level-3 conditions when tested per SEFA-3 Work Surfaces Chemical/Stain Resistance Test, shall have no more than four Level-3 conditions.

3. Color: Black

D. Epoxy Materials: Factory-molded, modified epoxy-resin formulation with smooth, non-specular finish.

1. Physical Properties:
 - a. Flexural Strength: Not less than 10,000 psi (70 MPa)
 - b. Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa)
 - c. Hardness (Rockwell M): Not less than 100
 - d. Water Absorption (24 Hours): Not more than 0.02 percent

- e. Heat Distortion Point: Not less than 260 deg F (127 deg C)
 2. Chemical Resistance: Not more than four Level-3 conditions when tested per SEFA-3 Work Surfaces Chemical/Stain Resistance Test, shall have no more than four Level-3 conditions.
 3. Color: Black
- E. Auxiliary Materials:
1. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
 2. Sealant:
 - a. Sealant Joints and Penetrations in Work Surface Materials: Silicon sealant recommended by work surface manufacturer.
 - b. Between Laboratory Casework and Adjoining Construction: Refer to Division 7 Section "Sealants".
 3. Corrosive Storage Cabinet Lining: Normal 3/16-inch (5mm) Polyethylene or polypropylene lining material.
 4. Hazardous Material Storage Cabinet Lining: Normal 3/16-inch (5mm) Polyethylene or polypropylene lining material
 5. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type 1, Class 1, Quality-Q3; not less than 5.0 mm thick.
 6. Steel Plates, Shapes and Bars: ASTM A 36/A 36M.
 7. Steel Tubing: ASTM A 500, cold-formed steel tubing.
 8. Steel Pipe: ASTM A 53/A 53M, standard weight(Schedule 40) unless otherwise indicated.
 9. Utility-Space Framing: Steel framing units consisting of 2 steel slotted channels complying with MFMA-4, not less than 1-5/8 inches square by 0.105 inch/12 gage (2.7mm) nominal thickness, and connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4 inch steel flat bars. Framing units may be welding specified channel material into rectangular frames instead of using U-shaped brackets
 10. Slotted Channel Framing: Cold formed metal box channels (struts) complying with MFMA-4
 - a. Structural Support Material: Cold-rolled steel, ASTM A 1001/A 1001M; structural steel, Grade 33; 0.105-inch/12 gage (2.7-mm) minimum thickness; coated with rust-inhibitive, baked-on acrylic enamel.
 - b. Channel Size: 1-5/8 inch square, except 7/8 inch by 1-5/8 inch units for miscellaneous pipe supports where indicated

2.3 FABRICATIONS

- A. Metal Tables:
1. Fabrication: Assemble and finish units at point of manufacture. Use Precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt and vermin-resistant enclosures.
 - a. Tables: Welded tubing legs; channel aprons, frames, leg rails and stretchers.
 - b. Adjustable height leveling devices; non-marring, non-metallic glides.
 - c. Legs shoes, open-bottom, slip-on type.
 - d. Casters: Rubber tire, swivel, locking type
 - e. Combination Casters: Zambus, Inc.; Carrymaster AC-300S, combination caster with nylon wheel and screw-type height adjustable rubber foot.
Adjustable Height Table: Telescoping, stainless steel inner leg; 30 inch to 40 inch height adjustment.

B. Wood Cabinets:

1. Veneer Matching: Provide veneers for each elevation from a single flitch, book or slip and balance matched.
 - a. Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
 - b. Provide continuous matching of adjacent fronts within each cabinet.
2. Edge banding for Wood-Veneered Construction:
 - a. Minimum 1/8-inch (3-mm) thick, solid wood of same species as face veneer.
3. Drawers:
 - a. Fronts: 3/4-inch (19mm) thick, MDF-core hardwood plywood or solid hardwood Box: 1/2-inch (12.7mm) thick, solid hardwood or veneer-core hardwood plywood; glued dovetail or multiple-dowel joints.
 - b. Bottoms: 1/4-inch (6.4mm) thick, hardboard (smooth side up); glued and dadoed into front, back and sides of drawers. Use 1/2 inch (12.7) thick material for
4. Adjustable Cabinet Shelves: 1-inch thick veneer core hardwood plywood; shelf lip at cabinets without doors.
 - a. Adjustable on 1-1/4 inch (32mm) centers
 - b. Depth: Full depth shelves
 - c. Front edge of shelf to be within 1 inch of inside face of door.
 - d. Cabinet Shelf Lip: Provide at cabinets without doors; 1/2 inch thick solid hardwood with top of lip minimum 1/2 inch above top of shelf.
5. Base cabinets with removable backs.
6. Ends of cabinets, including those installed directly against walls or other cabinets are defined as "exposed."

C. Special Purpose Cabinets:

1. Under-counter Corrosive Storage Cabinets:
 - a. Cabinet Material and Design: Metal laboratory casework with inset doors.
 - b. Cabinet Construction: Comply with requirements for metal laboratory casework and the following:
 - 1) Cabinet Use: Storage of acids and bases, where indicated on Drawings.
 - c. Cabinet Lining: Chemical resistant polyethylene; top, bottom, back, sides and inside of cabinet doors; 2-inch high lip at front cabinet opening; cabinet lining shall be liquid tight to minimum depth of 2 inches.
 - d. Cabinet Back: Removable back panels for access to utility chase from inside cabinet.
 - e. Shelves: Provide two, half-depth shelves with polyethylene or polyolefin spill tray with 1-inch high raised lip four sides of each shelf.
 - f. Cabinet Ventilation: Provide two vent outlets (one high/one low) at back of cabinet and polyethylene or polyolefin vent pipe up to fume hood, unless otherwise indicated to be exhausted by Mechanical Design.
 - g. Corrosions resistant cabinet hardware; cabinet locks; cabinet identification labels for material being stored. Provide cabinet lock.
2. Under-counter Flammable Liquid (Solvent) Storage Cabinets:
 - a. Cabinet Material and Design: Metal laboratory casework with inset doors.
 - b. Cabinet Construction: Comply with requirements of NFPA-30 and the following:
 - 1) Provide self-closing doors with fusible link and coordinator; doors shall be self-latching with three-point latch arrangement.
 - 2) Provide continuous stainless-steel piano hinges and cabinet locks.

- 3) Cabinet Back Option: Provide units with removable back where standard to manufacturer's listed and labeled products.
 - 4) Spill Containment: Cabinet bottom liquid tight to height of 2-inches; cabinet shelf spill tray.
 - 5) Cabinet Ventilation: Two, 2-inch diameter threaded pipe vent outlets (high and low at back of cabinet) with flame arrestors and bungs (caps). Vent outlets shall be capped, unless cabinets are otherwise indicated to be exhausted on the Mechanical Drawings.
 - 6) Cabinet identification labels. Flammable liquid (solvent) storage cabinets shall be identified with conspicuous, two-inch high lettering to read "FLAMMABLE KEEP FIRE AWAY" in color contrasting with the cabinet finish color.
 - 7) Cabinets listed and labeled per UL. Cabinets shall be listed and leveled per Quality Assurance Article in Part 1
 - a) Provide testing laboratory labels on top interior of cabinet door.
3. Under-counter Vented/Vacuum Pump Cabinets:
- a. Metal laboratory casework with inset doors; constructed without cabinet floor/bottom.
 - b. Cabinet Lining: Fully insulated, with cabinet interior.
 - c. Cabinet Back: Equip with vacuum service fitting, exhaust outlet, cabinet exhaust fan, pass-thru up to countertop for equipment services, and duplex electrical outlet controlled by switch on cabinet face panel.
 - d. Doors:; louvers thru door face for ventilation or thru toe-kick.
 - e. Pump Platform: Mobile platform raised lip four sides, pull handles, and rubber tire casters.
 - 1) Cantilever Table Frame: Welded cold rolled steel, designed for support of suspended casework. Equip frame with hanger hooks for 1 inch height adjustment; leveling/lock studs designed to engage uprights, allow height adjustment of front edge of frame, and prevent un-intended release.
 - 2) Standard Duty Cart: 900 lbs total load; work surface plus 600 lbs table frame rating.
 - 3) Combination Casters: Zambus, Inc.; Product – Carrymaster Model AC-300F
 - 4) Shelves: Shall be wood to match the fixed casework with room.
 - 5) Accessories:
 - a) Mount gases to vertical struts
 - b) Provide Electrical service strip
- D. Shelving:
1. Bench-Top Upright System: Casework manufacturer's integrated system of support structure and overhead storage components, designed for mounting on top of fixed casework countertops. Steel slotted vertical uprights for attachment of suspended components, adjustable in 1 inch increments; top rail, and base plates.
 - a. Provide suspended cabinets where indicated.
 - b. Provide adjustable shelving units where indicated.
 2. Wall-Rail System: Casework manufacturer's integrated system that includes support structure and cantilevered storage components mounted to building partitions. Steel slotted vertical rails for attachment of suspended components, adjustable in 1 inch increments; horizontal rails.
 - a. Provide suspended cabinets where indicated.
 - b. Provide adjustable shelving units where indicated.
 - c. Provide in-fill panels between vertical and horizontal rails.

3. Adjustable Wood Shelving Units with Metal Brackets: 1-inch thick veneer core hardwood plywood, edgebanded; cold rolled steel, bookend type brackets; bracket hooks compatible with bench-top uprights, wall rail system and movable workstation uprights; 1 inch adjustment; stainless steel shelf retainer rod at front edge.

E. Finishes:

1. Metal Finish: Color as selected by Architect. Two coat, chemical resistant baked-on finish. Comply with SEFA-8M; no more than four Level 3 conditions and within range for each chemical reagent.
 - a. Prepare, treat and finish welded assemblies after assembling. Prepare, treat and finish, components that are assembled with mechanical fasteners before assembling. Prepare, treat and finish concealed surfaces same as exposed surfaces.
 - b. Chemical-Resistant Finish: Laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 1.5 mil average and 1.2 mil minimum on exterior and interior surfaces exposed to view; 1.2 mil average on backs of cabinets and other surfaces not exposed to view.
 - 1) Ends of cabinets, including those installed directly against walls or other cabinets are defined as "exposed."
 - 2) Chemical and Physical Resistance of Finish System: Finish shall comply with acceptance levels of cabinets surface finish tests in SEFA 8-M. Acceptance level for chemical spot test shall be no more than four Level 3 conditions, and results shall be within the range indicated for each chemical reagent.
 - 3) Colors for Metal Laboratory Casework Finish: As selected by Architect from manufacturer's full range.
2. Wood Cabinet Finish: Staining as selected by Architect. Two coat chemical resistant transparent finish. Comply with SEFA-8W; no more than four Level 3 conditions and within range for each chemical reagent.
3. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard two-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.
 - a. Chemical and Physical Resistance of Finish System: Finish shall comply with acceptance levels of cabinet surface finish tests in SEFA 8-W. Acceptance level for chemical spot test shall be no more than four Level 3 conditions, and within the range of results indicated for each chemical reagent.

F. Hardware and Accessories:

1. Hinges: Stainless-steel five knuckle hinges with antifriction bearings and rounded tips. Provide 2 for doors 48 inches (1200mm) high or less and 3 for doors more than 48 inches (1200mm) high.
 - a. Provide full height, stainless steel piano hinges at under-counter flammable liquid (solvent) storage cabinets.
2. Hinged Door and Drawer Pulls: Provide stainless steel back-mounted pulls with lock washers.
3. Door Catches: Nylon-roller catches; spring-type elbow catches.
 - a. Base Cabinets: Attach to top of base cabinet doors
 - b. Wall and Upper Cabinets: Attach to bottom of wall cabinet doors
 - c. Tall Cabinets: Attach at top and bottom of doors.
4. Drawer Slides: Full extension, zinc plated with steel ball bearings; 100 lbs capacity; 150 lbs capacity for file drawers.

- a. Pull boards: Casework manufacturer's standard pull board suspension with minimum 75 pound dynamic load capacity and hold open feature.
 - b. Box Drawers and Pull-out Shelves: Medium Duty slides, minimum 100 lbs capacity.
 - c. File Drawers: Heavy-Duty slides, minimum 150 lbs capacity with over-travel.
5. Adjustable cabinet shelf supports.
 6. Hanging file frames at file drawers.
- G. Laboratory Work Surfaces:
1. Work Surfaces, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniform. Provide front and end overhang of 1 inch (25 mm) unless otherwise indicated.
 - a. Seal joint between curbs and adjoining construction
 - b. Seal joint between different work surface materials.
 2. Solid Composite Countertops: Fabricate with factory cutouts for sink, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal spline.
 - a. Tops: Flat, 1-inch thick, with beveled or rounded edge and corners, with drip groove on underside 1/2 inch (13mm) from edge.
 - b. Curbs: Loose, same thickness as tops.
 3. Epoxy Countertops at fumehoods: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.
 4. Tops: Flat, 1-inch thick, with beveled or rounded edge and corners, with drip groove on underside 1/2 inch (13mm) from edge.
Curbs: Loose, same thickness as tops
 - a.
- H. Laboratory Sinks:
1. Sinks, General: Provide sizes indicated or manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 - a. Outlets: Provide with strainers and tailpieces, NPS 1-1/2 (DN 40), unless otherwise indicated.
 - b. Overflows: For each sink except cup sinks, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches (50 mm) less than sink depth. Provide in same material as strainer.
 2. Epoxy Sinks: Molded in 1 piece; strainer and tailpiece; overflow; drop-in and under-mount; with adjustable support system.
 3. Stainless Steel Sinks: Made from stainless-steel sheet, not less than 0.050 inch (1.27 mm) nominal thickness. Fabricate with corners rounded and coved to at least 5/8 inch (16 mm) radius. Slope sink bottoms to outlet. Provide double-wall construction for sink partitions with top edge rounded to at least 1/2 inch (13 mm) diameter. Provide continuous butt-welded joints. After fabricating and welding, grind surfaces smooth and polish as needed to produce uniform finish with no evidence of welds and free of cross scratches. Passivate and rinse surfaces; remove embedded foreign matter and leave surfaces clean.
 - a. Punch holes for fittings at factory
 - b. Provide with stainless steel strainer and tailpiece
 - c. Provide with integral rims except where located in stainless-steel countertops.
 - d. Apply 1/8 inch (3mm) thick coating of heat-resistant, sound-deadening mastic to under-sink surfaces.

4. Cup Sinks: Material and size as indicated.
 - a. Provide epoxy cup sinks with polypropylene strainers and integral tailpieces.
 - b. Size: 3-by-6-inch oval

- I. Casework Accessories:
 1. Pegboards (Drying Racks):
 - a. Basis-of-Design Manufacturer: Inter Dyne Systems, Inc.; Products as indicated below or comparable products from laboratory casework manufacturer.
 - b. Stainless steel pegboard with removable polypropylene pegs, stainless steel drip trough with outlet and plastic drain hose; finished back and mounting hardware.
 - 1) Basis-of-Design Product: Inter Dyne Systems, Inc.; Product –MOD-RACK Stainless Steel Pegboard, Victoria Series, size as indicated on Drawings.
 - 2) Integral drip trough; length of pegboard by 2 inch wide by 1 inch deep, with drain grid and 36 inch clear flexible drain tube.
 - 3) Provide stainless steel finished back at units not mounted to partition
 - 4) Pegs, other accessories and mounting as indicated on Drawings.
 - c. Pegboard Accessories:
 - 1) Pegs: White polypropylene pegs; product standard peg length and quantity for pegboard size, unless otherwise indicated on Drawings
 - 2) Peg Hole Covers: White polypropylene hole covers where pegs not used.
 - 3) Pegboard Mounting:
 - a) Wall Mount Assembly: Wall bracket to allow removal and replacement of entire pegboard unit without need for tools.
 - b) Free Standing Assembly Brackets: Painted steel brackets anchored to countertop with stainless steel fasteners.
 - c) Raised Top Assembly: Stainless steel tube frame anchored to countertop.
 - d) Wall standard Mount: Stainless steel mounting clips welded to back of stainless steel pegboard for attachment to stainless steel slotted wall standard.
 - 4) Drain Shelf: Stainless steel, 12 inch long shelf unit with support pegs for installation, where indicated
 - 5) Drain Basket: Stainless steel, 12 inch long basket unit with support pegs for installation, where indicated.

- J. Water and Laboratory Gas Service Fittings:
 1. Basis-of-Design Manufacturer: Water Saver Faucet Co.
 2. Service Fittings: Provide units complying with SEFA-7, complete with washers, locknuts, nipples, and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods and similar items.
 3. Materials: Cast or forged brass; polypropylene, PVC or PVDF for reagent-grade water service fittings
 4. Finish: Satin nickel plated finish with baked on clear epoxy coating solvent-resistant powder coating complying with SEFA 7 for corrosion-resistant finishes.
 5. Water Valves and Faucets: ASME A112.18.1 with renewable seats; 80 psig.
 - a. Vacuum Breakers: ASSE 1035 or 1001.
 - b. Outlets: Aerators and serrated outlet.
 - c. Renewable Seat/Unit: Compression valve design with integral adjustable volume control.
 - d. Self-closing valves where indicated.
 6. Ball Valves: Up to 75 psig working pressure; no more than 5 lbf to operate handle; serrated outlet.

7. Needle Valves: Renewable self-centering, floating cones and stainless steel or Monel renewable seats.
 - a. Needle Valves: Up to 125 psig working pressure.
 - b. Fine Control Needle Valves: Up to 250 psig working pressure.
 - c. Pressure Regulators: Non-relieving type; 5 to 300 psig inlet pressure range; 5 to 125 psig outlet pressure range.
 - d. Outlets: Serrated hose end and keyed quick connect fittings as indicated.
 8. Remote Control Valves: Straight-through or angle type as required for fume hoods; front loaded type.
 - a. Outlet Finish: Acid and solvent-resistant powder coating complying with SEFA 7 for corrosion-resistant finishes; fitting color to identify service/media delivered.
 9. Handles: Four-wing molded plastic or powder coated metal handles for valves.
 - a. Accessible Sink Water Faucets: Blade-type handles.
 - b. Ball Valves: Forged brass lever-type handles.
 - c. Pure Water Valves: Knurled, molded plastic handles.
 - d. Pressure Regulators: Knurled, molded plastic handles.
 - e. Remote Control Valves: Four-arm color-coded molded plastic handles.
 - f. Remote Control Valves for Accessible Fume Hoods: Forged brass, lever-type handles.
 10. Service Identification: SEFA 7 color-coded plastic discs and embossed identification; color-coded handle with neutral color disk where handles are indicated to be color-coded.
- K. Electrical Service Fittings: UL listed metal housings, accessories and gaskets required for mounting on/in laboratory casework. Receptacles, data outlets, switches, pilot lights, device plates, and accessories are specified in Division 26 and 27 Sections. Device colors as indicated in Division 26 and 27 Sections.
1. Pedestal-Type Fittings: Cast aluminum housing with gasket; single or double faces.
 2. Line-type Fittings: Cast metal boxes for mounting on rigid steel conduit.
 3. Recessed-Type Fittings: Galvanized steel boxes.
 4. Pedestal- and Line-Type Fitting Finish: Chemical resistant clear, baked-on epoxy coating.

PART 3 - EXECUTION

3.1 CASEWORK INSTALLATION:

- A. Install plumb, level, true and aligned with no distortions. Shim, using concealed shims. Where laboratory casework abuts other finished work, scribe and apply filler strips for accurate fit with fasteners concealed. Fit scribe strips to irregularities of adjacent surfaces. Maximum gap opening shall be 0.025".
- B. Base Cabinets: Set cabinets straight, plumb, and level. Adjust sub-tops within 1/16" of a single plane. Bolt continuous cabinets together. Fasten continuous cabinets to floor at toe space, with fasteners spaced 24" on center. Secure individual cabinets with not less than two fasteners into floor, where they do not adjoin other cabinets. Assemble units into one integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16".
- C. Wall Cabinets and Shelves: Fasten to solid supporting material, not plaster, lath, or wallboard. Anchor, adjust, and align wall cabinets as specified herein for base cabinets. Reinforcement of stud walls to support wall-mounted cabinets and shelves will be done during wall erection by

trade involved, but responsibility for accurate location and sizing of reinforcement is part of this work.

- D. Install hardware uniformly and precisely after final finishing is complete. Set hinges snug and flat in mortises unless otherwise indicated. Turn screws to flat seat. Adjust and align hardware so that moving parts operate freely and contact points meet accurately. Allow for final field adjustment after installation.
- E. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.2 INSTALLATION OF TOPS:

A. General:

- 1. Field Jointing: Make in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted shop drawings, factory prepared so there is no job site processing of top and edge surfaces.

B. Epoxy resin tops:

- 1. Fastening: secure to cabinets with silicone adhesive applied at each corner and along perimeter edges at not more than 48" on center. Adhesive rather than epoxy cement is to allow for future disassembly and relocation.
- 2. Workmanship: Abut top and edge surfaces in one true plane, with internal supports placed to prevent any deflection. Provide flush hairline joints in top units using clamping devices.
- 3. Tolerances: Provide joint widths not more than 1/16" wide at any location, filled and flush with abutting edges. Horizontal alignment of top surface of all joints for their entire length shall be within 1/32". Front edges of all abutting pieces shall align.
- 4. Surface Finish: After installation, dress joints smooth, remove any surface scratches, clean and polish entire surface.
- 5. Verify field dimensions and that adjacent walls are square prior to installation.

3.3 INSTALLATION OF SINKS:

- A. Drop-in Installation: Use manufacturer's recommended adjustable support system for table-type and cabinet-type installations. Set top edge of sink unit pressed to countertop, set in manufacturer's recommended chemical resistant sealing compound to produce a tight and fully leak-proof joint. Adjust sink and support to prevent movement. Remove excess sealing compound once sink is set.

3.4 INSTALLATION OF ACCESSORIES:

- A. Install in a precise manner in accordance with manufacturer's directions. Turn screws to a flat seat; do not drive. Adjust moving parts to operate freely without excessive bind.

3.5 SITE CLEAN-UP:

- A. Procedure: It shall be the responsibility of Casework Contractor to remove his own packaging debris and other waste resulting from installation to the common disposal area on site.

3.6 CLEANING AND PROTECTION:

- A. Repair or remove and replace defective work as directed by the A/E upon completion of installation.
- B. Clean shop-finished surfaces, touch-up and remove or refinish damaged or soiled areas, as acceptable to A/E. Clean and polish all phenolic resin countertops with "Countertop Magic" or equal.
- C. Protection: Protect materials and installed laboratory casework and fixtures from damage by work of other trades.
- D.

3.7 SERVICE-FITTING SCHEDULE:

- A. Basis of Design:
 - 1. HCW-1: Hot/Cold Water Mixing Faucet, Deck Mounted.
 - a. Features: 6 inch spread, rigid gooseneck, vacuum breaker; Aerator; Wrist blade handle.
 - b. Model: WaterSaver L2221VB
 - 2. CW-2: Cold water Faucet,
 - a. Features: Single water faucet, deck mounted, 12" h x 6" rigid gooseneck, w/ vacuum breaker, removable serrated hose end; blade handle.
 - b. Model: Watersaver L611VB-BH
 - 3. PW: Pure Water Faucet for Lab Water, Deck Mounted; Left Hand
 - a. Features: Tin-Lined Brass, Self Closing Control, 6" Rigid Gooseneck, wrist blade handle
 - b. Model: WaterSaver L681
 - 4. EW-1: Eye Wash/ Drench Hose, Deck Mounted
 - a. Features: 2 spray heads side by side. Unit mounted at sink with backflow preventer
 - b. Model: WaterSaver EW1022BP-TMV
 - c. Location: At scullery sink, refer to plumbing drawings
 - 5. EW-2: Handicapped Accessible Eye Wash, Deck Mounted
 - a. Features: 2 spray heads side by side. Unit mounted at sink with backflow preventer
 - b. Model: WaterSaver EWBF849-TMV
 - c. Location: At all ADA sinks
 - 6. CA-1, V-1, SG-1, Laboratory Ball Valve, deck mounted single
 - a. Feature: Double gas valve 180deg., serrated hose end, lever handle
 - b. Model: WaterSaver L4200-132SWSA

7. CA-1-1, V-1-1, SG-1-1: Laboratory Ball Valve, panel/wall mounted single
 - a. Feature: single gas valve., serrated hose end, lever handle
 - b. Model: WaterSaver L4200-158WS
8. CA, V, SG: Laboratory Ball Valve, panel/wall mounted single
 - a. Feature: single gas valve., serrated hose end, lever handle
 - b. Model: WaterSaver L4200-158WS
9. SS-D: Safety Center
 - a. Feature: Recessed safety center with drain Pan, provide to monitor with Building management System and an electric light and Alarm horn.
 - b. Model: WaterSaver: GSC2662K-TMV-AP280-235
10. 120V-S1, DATA-S1: Electrical and data fittings:
 - a. Features: Deck mounted satin aluminum pedestal, single gang, single face; stainless steel face plate
 - b. Model: Watersaver E300WS-SA
- 11: DATA-S2: Electrical and data fittings:
 - a. Features: Deck mounted satin aluminum pedestal, single gang, double face; stainless steel face plate
 - b. Model: Watersaver E400WS-SA
12. 120V-D2: Electrical and data fittings:
 - a. Features: Deck mounted satin aluminum pedestal, double gang, double face; stainless steel face plate
 - b. Model: Watersaver E600WS-SA
13. 120V-D1: Electrical and data fittings:
 - a. Features: Deck mounted satin aluminum pedestal, double gang, single face; stainless steel face plate
 - b. Model: Watersaver E500WS-SA

END OF SECTION 12 3553

SECTION 123600 – COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for wall-hung counters and vanity tops.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 - 1. Basis of Design: Laminart.
 - a. Laminate Sheet, Type as indicated on drawings.: NEMA LD 3, Grade HGS, 0.048 inch (1.2 mm) nominal thickness.
 - 1) Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - 2) Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
 - b. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/4 inch (32 mm) thick; covered with matching laminate.
 - c. Back and End Splashes: Same material, same construction.
 - d. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Custom Grade.
- C. Solid Surface Countertops:

PART 3 EXECUTION

END OF SECTION 123600

SECTION 12 4053 LABORATORY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gas cylinder Rack
 - 2. Local exhaust vent systems.
 - 3. Special purpose safety cabinets.
- B. Owner-Furnished Equipment: Where indicated, Owner will furnish equipment for installation

1.2 QUALITY ASSURANCE

- A. Flammable Liquid Storage Cabinets: Listed and labeled as complying with requirements of NFPA 30 by UL or other qualified testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Hazardous Material Storage Cabinets: Listed and labeled as complying with requirements of NFPA 30 by UL or other qualified testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Electrical Components, Devices and Accessories: Listed and labeled per NFPA 70.

1.3 SUBMITTALS

- A. Submit complete submittal package of informational submittals. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.
- B. Informational Submittals:
 - 1. Coordination Drawings: For overhead supported equipment.
 - a. Indicate locations of overhead supported equipment and connections to utilities.
 - b. Key equipment using same designations as indicated on Drawings.
 - c. Include plans, reflected ceiling plans and elevations; clearance requirements for equipment access and maintenance; details of equipment supports; and utility service characteristics.
 - d. Include details of seismic bracing for equipment.
 - 2. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Experienced installers' who have completed installation of products similar to that indicated for this Project and whose work has resulted in a record of successful in-service performance. Where required by product manufacturer, installers' shall be authorized, trained and approved by equipment manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. UL Certification: Provide electric and fuel-burning equipment and components that are evaluated by UL for fire, electric shock, and casualty hazards according to applicable safety standards, and that are UL certified for compliance and labeled for intended use.
- D. Product Designations: Drawings or Specifications indicate sizes and configurations of laboratory equipment by referencing designated manufacturer's model numbers. Other manufacturers' laboratory equipment of similar sizes, configurations and complying with the Specifications may be considered.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install products until building is enclosed and weather tight, utility roughing-in and wet work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of the construction period.

1.6 COORDINATION

- A. Coordinate product layout and installation with other work, including layout and installation of framing, reinforcement required to support product, plumbing, fire protection, mechanical, electrical, and communications components.
- B. Coordinate locations and requirements of utility service connections.
- C. Coordinate sizes, locations, and requirements of the following:
 - 1. Overhead equipment supports and ceilings.

PART 2 - PRODUCTS

2.1 GAS CYLINDER RACKS

- A. Basis-of-Design Product: Safe-T-Rack Systems, Inc.; Models 2412 and 2422. See drawings for configuration indicated.
 - 1. Rack Fabrication: Welded steel tubing with baked-on powder-coat finish; dual safety chains at each cylinder bay; floor and wall mounting hardware.

2.2 LOCAL EXHAUST VENT SYSTEM (Snorkel)

- A. Basis-of-Design Product: Movex, Inc.; TERFU Local Extractor, Standard (Aluminum) model.
- B. Description:
 - 1. Ceiling Mounting Bracket: Anodized aluminum tube, internal epoxy coating, escutcheon, exhaust duct connection, seismic restraint, suspended from structure above.
 - 2. Arm Tube Assembly: Anodized aluminum tube sections with polypropylene joints; swivel assembly; adjustable friction joints; manual damper; 3 inch (76 mm) diameter tube, unless otherwise indicated.

3. Hood: Clear hood

2.3 SPECIAL PURPOSE SAFETY CABINETS:

- A. Basis-of-Design Manufacturer: Justrite Mfg. Co.; products as indicated.
- B. Tall Corrosives Storage Cabinets: Justrite Mfg. Co.; ChemCor Lined Safety Cabinets, Model No. 8945222; lined cabinet with hinged doors, self-closing and self-latching.
 1. Cabinet Construction: Steel construction with chemical resistant, baked-on powder coat finish. Equip cabinet with adjustable leveling feet. Color as selected by Architect.
 2. Door Style and Operation: 2-door, self-closing and 3-point self-latching; keyed lock and padlock eye handle.
 3. Storage Capacity: 45 gallon.
 4. Exterior Size: 65-inch high by 43-inch wide by 18-inch deep.
 5. Cabinet Lining: Chemical resistant, seamless, thermoplastic sprayed-on interior cabinet lining, bottom sump, interior door and shelves. Bottom sump liquid tight to height of 2 inches.
 6. Shelves: Two adjustable shelves with polyethylene spill trays.
 7. Ventilation: Two threaded pipe vent outlets (one high, one low) at sides of cabinet. Cabinets to be mechanically ventilated, refer to Division 23 Sections for supply and exhaust duct connections, including duct.
 8. Identification: Conspicuous, 2 inch high lettering warning label identifying material being stored (i.e. ACIDS, BASES, other as indicated) in color contrasting with the cabinet finish color.
 9. Cabinet Installation: Securely fasten cabinets to partition framing, blocking or other construction to prevent over-turning.
- C. Tall Flammable Liquid Storage Cabinets: Justrite Mfg. Co.; Sure-Grip EX Safety Cabinets, Model No. 894520; cabinet with hinged doors, self-closing and self-latching.
 1. Cabinet Construction: Steel construction complying with requirements of NFPA-30 and the authorities having jurisdiction, with chemical resistant, baked-on powder coat finish. Equip cabinet with adjustable leveling feet and grounding connector. Color as selected by Architect.
 2. Door Style and Operation: 2-door, self-closing and 3-point self-latching; keyed lock and padlock eye handle.
 3. Storage Capacity: 45 gallon.
 4. Exterior Size: 65-inch high by 43-inch wide by 18-inch deep.
 5. Cabinet Lining: Chemical resistant baked-on powder coat finish on interior of cabinet, bottom sump, interior of doors and shelves. Bottom sump liquid tight to height of 2 inches.
 6. Shelves: Two adjustable shelves.
 7. Ventilation: Two threaded pipe vent outlets with flame arrestors and caps (one high, one low) at sides of cabinet. Vent outlets shall be capped, unless otherwise indicated to be mechanically ventilated; refer to by Division 23 section for supply and exhaust duct connections, including duct.
 8. Identification: Conspicuous, 2 inch high lettering warning label reading "FLAMMABLE KEEP FIRE AWAY" color contrasting with the cabinet finish color.
 9. Labeling: Listed and labeled as indicated in Quality Assurance Article or constructed as required by the Fire Code and acceptable to authorities having jurisdiction.
 10. Cabinet Installation: Securely fasten cabinets to partition framing, blocking or other construction to prevent over-turning.

- D. Tall Flammable Liquid Storage Cabinets: Justrite Mfg. Co.; Sure-Grip EX Slimline Safety Cabinets, Model No. 892220; cabinet with hinged doors, self-closing and self-latching.
1. Cabinet Construction: Steel construction complying with requirements of NFPA-30 and the authorities having jurisdiction, with chemical resistant, baked-on powder coat finish. Equip cabinet with adjustable leveling feet and grounding connector. Color as selected by Architect.
 2. Door Style and Operation: 1-door, self-closing and 3-point self-latching; keyed lock and padlock eye handle.
 3. Storage Capacity: 22 gallon.
 4. Exterior Size: 65-inch high by 23.24"-inch wide by 18-inch deep.
 5. Cabinet Lining: Chemical resistant baked-on powder coat finish on interior of cabinet, bottom sump, interior of doors and shelves. Bottom sump liquid tight to height of 2 inches.
 6. Shelves: Three adjustable shelves.
 7. Ventilation: Two threaded pipe vent outlets with flame arrestors and caps (one high, one low) at sides of cabinet. Vent outlets shall be capped, unless otherwise indicated to be mechanically ventilated; refer to by Division 23 section for supply and exhaust duct connections, including duct.
- E. Tall Flammable Liquid Storage Cabinets: Justrite Mfg. Co.; Sure-Grip EX Deep Slimline Flammable Safety Cabinets, Model No. 895420; cabinet with hinged doors, self-closing and self-latching.
1. Cabinet Construction: Steel construction complying with requirements of NFPA-30 and the authorities having jurisdiction, with chemical resistant, baked-on powder coat finish. Equip cabinet with adjustable leveling feet and grounding connector. Color as selected by Architect.
 2. Door Style and Operation: 1-door, self-closing and 3-point self-latching; keyed lock and padlock eye handle.
 3. Storage Capacity: 54 gallon.
 4. Exterior Size: 65-inch high by 23.24"-inch wide by 34-inch deep.
 5. Cabinet Lining: Chemical resistant baked-on powder coat finish on interior of cabinet, bottom sump, interior of doors and shelves. Bottom sump liquid tight to height of 2 inches.
 6. Shelves: Three adjustable shelves.
 7. Ventilation: Two threaded pipe vent outlets with flame arrestors and caps (one high, one low) at sides of cabinet. Vent outlets shall be capped, unless otherwise indicated to be mechanically ventilated; refer to by Division 23 section for supply and exhaust duct connections, including duct.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb, according to manufacturer's written instructions.
1. Verify utility services are in required locations and are ready for use before installation of equipment.
 2. Complete equipment assembly where field assembly is required.
 3. Connect equipment to utilities.
- B. Install equipment with access and maintenance clearances that comply with manufacturer's written installation instructions and requirements of authorities having jurisdiction.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections:
 - 1. Perform visual, mechanical and electrical inspection and testing for each product according to manufacturers' written recommendations. Certify compliance with each manufacturer's equipment-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
 - 5. After making corrections, retest products that failed to perform.
- B. A product will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 CLEANING AND PROTECTION

- A. After completing installation of equipment, repair damaged finishes.
- B. Clean and adjust equipment as required to produce ready-for-use condition. Adjust hardware and moving parts to function smoothly, and lubricate as recommended by manufacturer.
- C. Protect equipment from damage during remainder of the construction period.

END OF SECTION 12 4053

SECTION 124813 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Entrance mats in recessed frames.

PART 2 - PRODUCTS

- A. Recessed Frames:
 - 1. Extruded Aluminum: ASTM B 221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
 - 2. Color: As selected by Architect from manufacturer's full range.
 - 3. Architectural Bronze: ASTM B 455, Alloy UNS No. C38500.

2.2 ENTRANCE MATS

- A. Manufacturers:
- B. Basis-of-Design Product: Construction Specialties Inc.: Peditred

PART 3 - EXECUTION

END OF SECTION 124813

SECTION 124813 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Entrance mats in recessed frames.

PART 2 - PRODUCTS

- A. Recessed Frames:
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 - 2. Color: As selected by Architect from manufacturer's full range.
 - 3. Architectural Bronze: ASTM B 455, Alloy UNS No. C38500.

2.2 ENTRANCE MATS

- A. Manufacturers:
- B. Basis-of-Design Product: Construction Specialties Inc.: Peditred

PART 3 - EXECUTION

END OF SECTION 124813

SECTION 14 2400 – HYDRAULIC ELEVATORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Hydraulic Passenger Elevators.
 - 1. Machine Room-less.
- B. Products supplied but not installed under this Section:
 - 1. Hoist Beam
 - 2. Pit Ladder
 - 3. Inserts mounted in block walls for rail attachments
- C. Elevator Smoke Curtain

PART 1 PRODUCTS

1.02 ELEVATOR MANUFACTURER

- A. Basis of Design: ThyssenKrupp: Endura MRL Low Rise Elevator
 - 1. Machine Room-less.

1.03 ELEVATOR SMOKE CURTAIN MANUFACTURER

- A. Basis of Design: Smoke Guard System: Model 200

PART 2 EXECUTION

END OF SECTION 142100

SECTION 21 0510 - GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Definitions
- B. Quality Assurance Requirements and Installer Qualifications
- C. Regulatory Requirements indicating applicable Codes, Ordinances and Regulations.
- D. Submittal Procedures Supplementing Section 01 3300.
- E. Operating and Maintenance Manuals
- F. Execution Requirements common to Division 21 systems
- G. Pipe Sleeves within building
- H. Pipe Sleeves in footings and foundations
- I. Piping Pressure Tests.
- J. Equipment bases and housekeeping pads
- K. Cleaning Requirements.
- L. Finishing Requirements

1.2 RELATED SECTIONS

- A. Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Section 01 7700 - Closeout Procedures, for additional warranty requirements.
- C. Section 07 8400 - Firestopping.
- D. Section 07 9200 - Joint Sealants
- E. Section 09 9100 - Painting.

1.3 ALTERNATIVES

- A. Refer to Section 01 2300 - Alternatives, for product alternatives affecting this Division.

1.4 DEFINITIONS

- A. **Manufacturer's Representatives:** Wherever MANUFACTURER'S REPRESENTATIVE is referred to in this division, said representative shall be regularly employed by the manufacturer to perform similar activities to those called for herein, which indicates his competence in that field of work.
- B. **Concealed:** Where the word concealed is used in this Division, it shall mean items above ceilings, in attics, in crawl spaces, in chases, in tunnels, in cabinet work, and under counters or equipment so as to be not visible from an elevation of 5 feet at a horizontal distance of 10 feet.
- C. **Finished Spaces or Areas:** Where finished spaces or areas are referred to in this Division, it shall mean all spaces except concealed spaces, mechanical rooms, or boiler rooms unless otherwise noted.
- D. **Provide:** Furnish and install.
- E. **Diagrammatic:** A drawing that shows arrangement and relations (as of parts).i.e.: A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts, conduit and other items shown and is not necessarily to scale. Arrangement, location, and sizes shown are firm.
- F. **Readily Accessible:** Equipment, valves and other items requiring service shall be installed to be readily accessible. These items shall be available for maintenance or use in a space, through an access door from floor elevation, or above a lay-in ceiling by maintenance staff standing on a ladder no taller than the ceiling.
- G. **Noted, Indicated or Shown:** Where the terms "Noted", "Indicated" or "Shown" are used in these specifications, the words "in the specifications or on the plans" shall be inferred.
- H. **Detail:** Where reference is made to a Detail, the Detail shall be on the plans unless otherwise noted.
- I. **Specifications:** Where reference is made to these specifications, it shall be inferred in this Division of specifications.
- J. **Notification by the Contractor, and Instructions to the Contractor:** Where reference is made in these specifications to notification by or instructions given to the Contractor, it shall be inferred that Architect shall be the instructor or shall be notified, as the case exists.
- K. **Division or Section Reference:** Where reference is made to another Division or Section within this Division, refer to specifications table of contents for Division, Section, or Page Number.

1.5 REGULATORY REQUIREMENTS

- A. Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications.

- B. Materials and equipment included in Underwriters Label Service shall bear that label. Electrical equipment shall be U.L. approved as installed.
- C. Jurisdiction: Where codes or guides refer jurisdiction to local governing code officials, such official in this procedure shall be the State Fire Marshal.
- D. Permits: Obtain all permits, paying all fees in connection therewith. At completion, have work inspected by proper authorities and furnish Architect for Owner an inspection certificate showing approval of installation.
- E. Fire Protection: Conform to the Georgia State Minimum Standard Fire Code (International Fire Code), 2018 Edition, with all Georgia State Amendments.
- F. Fire Prevention Precautions in Cutting and Welding Areas: Conform to Article 2605 Fire Prevention Precautions, International Fire Code, 2018 Edition, with all Georgia State Amendments, for all work involving cutting and welding.
- G. Energy: Conform to the Georgia State Energy Code for Buildings (International Energy Conservation Code), 2015 Edition, with all Georgia State Amendments.
- H. All Work: Conform to State of Georgia Chapter 120-3-3 "Rules of Safety Fire Commissioner, Rules and Regulations, January 1st. 2020".
- I. Electrical: Refer to Division 26. Conform to the National Electrical Code, NFPA 70, 2017.
- J. Building Code: Conform to the International Building Code, 2018 Edition with all Georgia State Amendments.

1.6 PERFORMANCE REQUIREMENTS

- A. Requirements specified herein are minimum. All equipment, when installed, shall perform equal to or exceed specified requirements.

1.7 SUBMITTALS

- A. Supplementing Division 1 requirements; Contractor shall:
 - 1. Review the submittal data and check to ensure compliance with specifications prior to submitting.
 - a. The Contractor agrees that submittals of equipment and material and shop drawings of equipment and material layouts required under provisions of these specifications and processed by Architect are not Change Orders. The purpose of submittals is to demonstrate that Contractor understands the design concept of the project by indicating the equipment and materials he intends to furnish and install, and by detailing the installation he intends to achieve.
 - b. The Contractor shall conform to the requirements of the Contract Documents unless a change order is issued. The Contractor shall identify on each submittal and in letter form to the Design Professional any and all deviations from the Contract Documents.
 - c. Any submittal or shop drawing not conforming to the Contract Documents without this identification and notification shall be assumed to be marked

- "Revise and Resubmit" (acknowledges this by the submission), and Contractor shall promptly resubmit said submittal so as to be in full compliance with the Contract Documents.
- d. Failure of Contractor to provide this information during the shop drawing phase shall make Contractor responsible for all changes to achieve compliance with the Contract Documents without additional compensation.
2. Assemble the submittal data in complete sets in hard back three-ring binders, and bound with numbered index sheets and tabs. Submittal data shall be submitted at one time unless unavailable data would delay project progress. Data shall include capacities, complete installation instructions, dimensional data and electrical data, BHP, motor HP, operating weights and load distribution at mounting points.
 3. Identify all submittals by a cover sheet showing project name, specification sections, drawing or detail number, room number, date, revision date, contractor and subcontractor's organization and project manager with phone number, the model, style and size of item being submitted with manufacturers' representative, salesman (or a preparer who can answer questions), and Preparer's phone number.
 4. Manufacturers' standard drawings shall be modified by deletions or additions to show only items applicable to this project.
 5. Prepare a master list of submittal proposed to be submitted on the project. This list shall be updated for each submission and shall be the first sheet(s) of the submission in the quantity that is submitted for review. The information and general format shall contain an Tab number, Item Description, Item Status and any comment.
 6. Provide a Letter stating that all submittals have been checked for compliance with specifications.
 7. Deliver submittals to the Design Professional at the business address.
 8. Digital Delivery of Submittals:
 - a. Submittal data may be posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and a password.
 - b. Prepare the submittals as described above in Sections 1.7.A.1-7. Provide one pdf file for each specification section including all submittal data for that specification section. Provide labels identifying each piece of equipment, piping, or accessory to match the listed item in the specification. Take steps to reduce submittal file size.
 - c. Do not scan in color or high resolution unless required for clarity.
 - d. Ensure any reproductions are legible.
 - e. Send an email to submittal@nbpengineers.com with a copy to all Design Professionals identified during the preconstruction phase.
 - f. Identify the submittal using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building- Section 21 1300 - Fire Suppression Sprinklers.
 - g. Identify the submittal in the email subject line using the same information listed above.
 - h. Provide a submittal index.
 - i. Each pdf should include bookmarks to each product, and specification section to easily navigate the pdf file.
 - j. Ensure any submittal posted to NBP's or other FTP site has the same identification.

- k. NBP Design Professionals will not process or react to submittals which are not properly transmitted, indexed, and identified.
- B. Product Data:
 - 1. Provide data specific to the Product proposed indicating capacity data, all standard and optional features to be supplied and all accessories and options available for that product.
 - 2. Manufacturer's standard drawings shall be modified by deletions or additions to show only items applicable to this project.
- C. Warranty: Submit Contractor's warranty letter addressed to Owner stating the correct project name and number, if applicable, the warranty period and ensure that form has the correct date of Material Completion.

1.8 OPERATING AND MAINTENANCE MANUALS

- A. Operating and Maintenance Manuals shall be prepared by the Contractor for all equipment and be submitted for review a minimum of prior to the request for Material Completion.
- B. Digital delivery of Operating and Maintenance Manuals:
 - 1. Operating and Maintenance Manuals may be delivered digitally and posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and password.
 - 2. Prepare the Operating and Maintenance Manuals as described above. Take steps to reduce submittal file size.
 - 3. Do not scan in color or high resolution unless required for clarity.
 - 4. Ensure any reproductions are legible.
 - 5. Send an email to submittal@nbpengineers.com with a copy to the Fire Protection Design Professional and the Architectural Design Professional (if applicable) identified during the preconstruction phase.
 - 6. Identify the manuals in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building.
 - 7. Table of Contents(Index) sheets shall be included in the order listed with identifications typed in capital letters.
 - 8. The O&M Pdf should contain bookmarks to each section of the manual, and bookmarks to each product.
 - 9. Ensure the manuals posted to the FTP site has the same identification.
 - 10. NBP Design Professionals will not process or react to manuals which are not properly transmitted, indexed, and identified.
- C. Each Manual shall contain the following information, data and drawings:
 - 1. Copies of all submittals (with Design Professional's review comments and stamp), equipment and materials.
 - 2. Manufacturer's installation, operating and maintenance instructions for each item of equipment with moving parts including recommended frequency of inspections and maintenance for one year of facility operation.

3. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
4. One copy of NFPA 25.
5. One Copy of as-built shop drawings showing layouts and construction details.
6. One copy of hydraulic calculations.
7. Copies of all certification, test certificates, and warranties.

1.9 QUALITY ASSURANCE

A. Fire Protection Installer Qualifications:

1. Wherever the word "company" or "firm" is used in these subparagraphs, it shall mean the contractor/subcontractor of record for the installations used for proficiency qualification.
2. Refer to the individual sections within this division for additional installer qualification requirements.
3. Fire Protection
 - a. The contractor expressly warrants that the company performing the installation of the fire protection systems has demonstrated proficiency in the installation, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least 10 commercial or institutional buildings, each containing minimum of 10,000 ft² of protected area or greater.
 - b. The contractor further warrants that the aforesaid subcontractor has trained personnel, instruments, tools, and equipment to perform the installation specified.
 - c. The Contractor also warrants that the aforesaid installer has been in business performing services of the nature specified herein for at least the previous five consecutive years in the state of Georgia.
 - d. Provide a certificate of competency as issued by the Georgia State Fire Marshal's Office.

1.10 PRODUCT DELIVERY, STORAGE, AND PROTECTION

- A. Accept all products on site in factory-fabricated protective containers. Inspect for damage.
- B. Store products up off the floor, in a clean dry place and protect from weather and construction traffic.
- C. Handle products carefully to avoid damage to components, enclosures, and finish.
- D. After placement, protect products from damage during construction, by all trade contractors.
- E. Protect equipment nameplates and labels from damage, being painted, scaring, etc.

1.11 WARRANTY

- A. Refer to Section 01 7700- Closeout Procedures, for additional warranty requirements.

- B. Where extended warranties beyond Contractor's one (1) year warranty are specified, the additional warranty time shall start at the end of Contractor's warranty.
- C. Correct defective Work for a one year period after Date of Material Completion.

PART 2 PRODUCTS-NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Hazardous Materials:
 - 1. A/E's Responsibility: Plans and specifications have been prepared by the A/E for Owner without the A/E having conducted investigation as to the presence of asbestos or hazardous waste on the project. Not being a part of this contract, the A/E has not charged any fees and has not and will not advise Owner with regard to the detection and/or removal of asbestos or hazardous waste. Owner is aware that asbestos or hazardous waste could be present and will make all decisions with regard to its removal. The removal of all hazardous materials and encapsulation of remaining surfaces is the sole responsibility of Owner.
 - 2. If Contractor observes the existence of a friable material which must be disturbed during the course of his work, Contractor shall promptly notify Owner and Architect. Owner shall make all arrangements regarding testing and removal or encapsulation of asbestos material if present. Contractor shall not perform any work pertinent to the friable material prior to receipt of special instructions from Owner through Architect.
 - 3. "Friable Material" is any material which can be crumbled, pulverized or reduced to a powder by hand pressure when dry.
- B. Refer to the specifications and Architectural and Structural drawings for additional requirements pertaining to work under this discipline. Notify Architect for clarification in the event of conflict.
- C. All materials of systems installation exposed in hollow spaces that are used as ducts or plenums shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less.

3.2 PREPARATION

- A. Drawings are diagrammatic and show the general proximity of the equipment, sprinkler heads, and some pipes, etc., are not to be scaled, and do not include all required changes in direction or offsets necessary in coordinating the installation of various materials either between trades or within the same trade. All dimensions shall be verified at the building site. Prefabrication and/or installation of work from drawings shall be at Contractor's risk. Refer to Architectural plans for exact building dimensions and details.
- B. Space Conditions:
 - 1. All apparatus shall fit into the available spaces in the building and must be introduced into the building so as not to cause damage to the structure. Equipment larger than access to equipment spaces shall be disassembled into sub-assemblies for installation.

2. Where deviations from the plans are required in order to conform to the space limitations, such changes shall be made at no additional cost to Owner and shall be subject to approval.
 3. All equipment requiring service shall be made accessible. Coordinate piping and sprinkler head installation to avoid conflict with other trades.
- C. Where new work is specified tying into old work and materials are different from existing, the contractor shall request a clarification from Architect prior to performing the work.
- D. The demolition plan has been prepared to assist the contractor in determining the scope of demolition work and should not be construed to be all of the demolition required. The contractor shall visit job site (after carefully reviewing the contract documents) and determine exact areas and quantities of existing materials to be removed to accomplish new construction.

3.3 INSTALLATION

- A. Clearance above and in front of electrical switchgear, electrical power panels or control panels shall be maintained by fire protection systems so that no sprinkler piping, or equipment is routed above or across the space directly above this equipment in conformance with the National Electrical Code.
- B. All equipment shall be installed in accordance with manufacturers' published installation instructions shipped with the equipment. In the event there is a discrepancy between these specifications or Drawings and the manufacturers' instructions, no work shall be performed until additional instructions are received.
- C. Install and connect all appliances, equipment, and appurtenances as specified, indicated or required in accordance with the manufacturer's instructions and recommendations. Furnish and install complete auxiliary piping, water seals, valves, electric connections, and similar items, recommended by the manufacturer or as required for proper operation.
- D. Route piping to avoid skylights, translucent, and transparent ceilings.
- E. Pipe Sleeves in Slabs, Masonry Walls and Partitions:
1. Provide sleeves in all slabs and walls/partitions unless otherwise noted.
 2. Omit sleeves on steel pipe through slabs on grade.
 3. Elevated Slabs: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a slab.
 4. Masonry Partitions: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated masonry wall/partition.
 5. Omit sleeves in openings core drilled in masonry partitions.
 6. Rated Drywall Partitions: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around the insulation. Install, without developing a break in the pipe insulation, according to the fire sealant

manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated drywall wall/partition.

7. Non-Rated Drywall Partitions: Omit sleeves.
- F. Pipe sleeves in footings and foundation walls:
 1. Schedule 40 black steel pipe.
 2. Fire Protection water pipe, distribution piping, passing under a footing or through a foundation wall shall be installed in a pipe sleeve, two pipe sizes larger than the pipe passing through.
 3. Sleeves in walls to spaces below grade shall be provided with 10 gauge leak plates.
 - G. Seal sleeves and openings in mechanical room walls, fire rated partitions, and floors above grade vaportight, watertight, or for smoke/fire protection as applicable. Refer to Section 07 8400 - Firestopping.
 - H. Seal sleeves and openings in exterior walls vaportight or watertight as applicable. Refer to Section 07 9200 - Joint Sealants.
 - I. Equipment and pipe support upper attachments shall be 3" x 3" x 1/4" galvanized steel angles, minimum, spanning structural members unless noted otherwise. Provide inserts and bolts for supporting pipes and equipment from structural members.
 - J. Saw cut or core drill openings in existing work for the installation of the mechanical system. Patching shall be performed by the trade whose work is cut. Contractor shall lay out and install his work ahead of the work of other trades wherever possible.

3.4 INTERFACE WITH OTHER WORK

- A. Space Conditioning during construction:
 1. Coordinate with the contractor regarding the limits of space conditions specified in other trade sections. Assist Contractor in the preparation of the construction schedule.

3.5 PIPING PRESSURE TESTS

- A. General:
 1. Provide 48 hours notification to Architect in advance of any test.
 2. Complete tests prior to installing ceiling. Leaks shall be repaired, defective materials replaced, and system shall be retested. Strike all joints in copper and steel piping under a pressure test. Conduct tests prior to connecting to equipment or isolate equipment from system.
 3. No water pressure test shall be conducted in freezing weather where subject to freezing.
 4. Test shall be maintained at conditions specified until approved but, in no event, for less than two (2) hours minimum duration, unless otherwise noted.
 5. Hydrostatic pressure tests shall maintain pressure without change, except that due to temperature change.

6. Test pressures shall be read from a gauge located at the low elevation point of the system being tested.
- B. Wet Sprinkler System:
 1. Hydrostatic Test; 200 PSIG
 2. Portions of the system normally subjected to working pressures in excess of 150 PSIG shall be tested at 50 PSIG higher than the normal working pressure of the system.
 - C. Water Service to Fire Protection System: Hydrostatic test, 200 PSIG.

3.6 EQUIPMENT BASES and HOUSEKEEPING PADS

- A. Provide housekeeping and equipment bases as shown or listed below. Rough up slab under bases before pouring concrete.
- B. Materials: Refer to Section 03 3000 - Cast-in-Place Concrete. Omit test cylinders for concrete poured under this section.
- C. Bases/Pads shall be rectangular with vertical sides 4-inches from centerline of anchor bolts or 2 inches from edges of equipment supports, whichever provides the larger dimension, side of equipment or base edge, unless otherwise noted.
- D. Height:
 1. Pumps on Grade: 4-inch concrete base.
 2. Concrete curb at all pipe penetrations of floors in mechanical rooms above grade: 4-inches or as shown on plans.
- E. Chamfer: 3/4-inch on edges and corners.
- F. Reinforcing: 6"x 6" 10/10 WWF at mid-depth of slab. (4 inch thick pads.)

3.7 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. Instruct operating personnel designated by the Using Agency in operation and maintenance of system prior to request for final inspection. Provide signed statement certifying instructions have been received.
- B. A manufacturer's service representative shall provide the instructions for each piece of equipment on system when specified in other Sections of this Division. A manufacturer's sales representative is not acceptable. (The instructor shall not be a sales person, but shall have service experience on a continuing basis and be knowledgeable about the subject equipment.)
- C. The Contractor shall give notice to Architect not less than 60 days of the anticipated date of instruction to allow planning by the Using Agency.
- D. The contractor shall give an orientation session to operating personnel for achieving familiarity (not instructions) of the systems approximately 5 days prior to the instruction

date. The Contractor's representative giving instruction shall be knowledgeable in the equipment/systems to allow quality recordings by the Using Agency.

- E. The Contractor shall develop not less than three (3) copies of the instructions with an index for easy retrieval of information.

3.8 CLEANING and PROTECTION

- A. All materials, equipment and mechanical rooms shall be cleaned prior to Material Completion.
- B. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish.
- C. Chipped or scraped paint shall be retouched to match original finish.
- D. Clean and polish all equipment nameplates. All nameplate information shall be legible.
- E. All equipment, pipe, pipe fittings and appurtenances shall be free of dust, rust and stains prior to Material Completion.

3.9 FINISHING MECHANICAL EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint shop-primed equipment.
- C. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- D. Paint all exposed pipes, unless otherwise indicated.
- E. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish or in mechanical rooms shall be painted to prevent rust.

END OF SECTION 21 0510

SECTION 21 1100 - FIRE SUPPRESSION PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe, fittings, valves, and connections for sprinkler systems.

1.2 RELATED SECTIONS

- A. Section 21 0510 - General Fire Suppression Requirements
- B. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.
- C. Section 21 1200 - Fire-Suppression Standpipes: Standpipe design.

1.3 REFERENCES

- A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- B. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings; The American Society of Mechanical Engineers; 2003 (ANSI/ASME B16.5).
- D. ASTM A 47/A 47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2004).
- E. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2006a.
- F. ASTM A 135/A 135M - Standard Specification for Electric-Resistance Welded Steel Pipe; 2006.
- G. ASTM A 795/A 795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2004.
- H. AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids; American Water Works Association; 2003.
- I. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; American Water Works Association; 2007 (ANSI/AWWA C111/A21.11).
- J. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2002 (ANSI/AWWA C151/A21.51).

- K. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2019.
- L. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; National Fire Protection Association ; 2019.
- M. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances; National Fire Protection Association; 2019.
- N. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems; 2017.
- O. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals, 2019.
- P. NFPA 72 - National Fire Alarm Code; 2019.
- Q. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; 2018 with all Georgia State Amendments.
- R. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants; 2018.
- S. Georgia State Minimum Standard Fire Prevention Code, 2018 Edition, with all Georgia State Amendments.
- T. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.
- U. UL 262 - Gate Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2004.
- V. UL 312 - Check Valves for Fire-Protection Service; Underwriters Laboratories Inc.; 2004.
- W. Chapter 120-3-3 of the Rules of the Safety Fire Commissioner dated January 1st. 2020.
- X. Georgia State Minimum Standard Building Code (International Building Code), 2018 Edition, with all Georgia State Amendments. NFPA Code, where more stringent, shall take precedence.

1.4 SUBMITTALS

- A. Refer to Section 21 0510 - General Fire Suppression Requirements for submittal procedures and requirements.
- B. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.5 QUALITY ASSURANCE

A. Fire Protection

1. The Contractor expressly warrants that the company performing the installation of the fire protection systems has demonstrated proficiency in the installation, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least 5 commercial or institutional buildings, each containing minimum of 10,000 ft² of protected area or greater.
2. The Contractor further warrants that the aforesaid subcontractor has trained personnel, instruments, tools, and equipment to perform the installation specified.
3. The Contractor also warrants that the aforesaid installer has been in business performing services of the nature specified herein for at least the previous five consecutive years in the state of Georgia.
4. Provide a certificate of competency as issued by the Georgia State Fire Marshal's Office.

B. Conform to UL and FM requirements.

C. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

D. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.1 GENERAL SYSTEM AND PRODUCT REQUIREMENTS

A. Sprinkler Systems: Conform work to NFPA 13.

B. Welding Materials and Procedures: Conform to ASME Code.

C. Building is Light Hazard . Pipe sizes shall be hydraulically calculated based upon contractor's flow test performed prior to construction. Flow test results at time of design: 135 PSI static, 85 PSI residual at 1,520 GPM flow.

D. Provide hydraulic calculations over the most remote 1500 square feet providing density required for hazard as indicated in NFPA 13. Minimum discharge pressure shall be 7.0 PSI. Minimum residual pressure at city water main in the street shall be 20.0 PSI. Provide 10.0 PSI minimum safety margin in hydraulic calculations at design point. Design area reduction per NFPA 13 is not allowed.

- E. Basis of design: Flow rate above is based upon the flow test provided by City of Dahlongega on the 12" main at Fire Hydrant #312 at the entrance to campus. Contractor shall perform, or have performed, at the same time, a Fire Flow and Twenty Four Hour Static Test to assure flow equals or exceeds specified basis of design flow rate prior to preparing shop drawings, installing system or performing calculations. Prepare calculations based on confirmed flow data or basis of design flow data, whichever is lowest. Flow test shall be performed in accordance with NFPA 13, NFPA 291, and Rules and Regulations of Safety Fire Commissioner, O.C.G.A. Chapter 120-3-3. Modify flow test pressures (static and residual), if pressure recorded in 24 hour test is lower than flow test pressures for minimum one hour duration, to lowest hour test pressure.
- F. No pipe shall be routed above electrical panels and equipment as required by National Electrical Code, on control side or beneath suspended mechanical equipment except where specifically required by Code, in which case, provisions shall be made for service access and removal.
- G. Where available, piping to sprinklers in all electrical and IT rooms, shall enter over interior doors.
- H. Inspectors test connection(s) shall discharge to the outside of the building in location(s) acceptable to Design Professional.
- I. Inside auxiliary drains, if needed, shall discharge in location(s) acceptable to the Design Professional. Drain and test connection piping, if in finished space, shall be installed concealed.

2.2 ABOVE GROUND WET SYSTEM PIPING

- A. Steel Pipe: ASTM A 795 Schedule 10 or ASTM A 53 Schedule 40, black. Piping 1 1/2" and smaller shall be threaded. Piping 2" and larger shall be grooved with rigid couplings.
 - 1. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A 47/A 47M.
 - 2. Mechanical Grooved Couplings: Rigid ductile iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe. Reducing couplings and flanges are NOT allowed.

2.3 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1" to 4": Carbon steel, adjustable swivel ring.
- B. Hangers for Pipe Sizes 6-inches and Over: Carbon steel, adjustable, clevis.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Vertical Support: Steel riser clamp.
- E. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- F. Provide support for any vertical pipe 36" in length or greater except armovers. Provide supports 12'-0" O.C. maximum or at floor levels.

- G. Threaded rods shall NOT be bent. Bending is permitted only in unthreaded sections of hanger rods. Bending shall occur as close to the hanger as possible. Provide a swivel assembly if required.
- H. Hangers when Pressure exceeds 100psi: Provide surge clips or extend threaded rod to secure sprinkler pipe to hanger for the last hanger closest to the end sprinkler head in a pendent position to prevent upward movement, Refer to NFPA 13 9.2.3.4.4 and 9.2.3.5.2.

2.4 GATE VALVES

- A. Up to and including 1 1/2 Inches:
 - 1. Manufacturers:
 - a. Nibco Scott; Product T-104-O
 - b. Hammond; Product 1B681
 - c. Stockham; Product B-133
 - d. Kennedy; Product Fig. 66
 - 2. Bronze body, bronze trim, rising stem, handwheel, solid wedge or disc, threaded ends.
- B. 2 inches and Larger:
 - 1. Manufacturers:
 - a. Nibco Scott; Product F-607-OTS
 - b. Crane; Product 467
 - c. Hammond; Product 1R1154
 - d. Mueller; Product R-2361-6
 - e. Kennedy; Product Fig. 68
 - f. Victaulic
 - 2. Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, handwheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged or grooved ends, 200 PSIG working pressure.

2.5 GLOBE VALVES

- A. Bronze body, rubber disc, union bonnet, 174 W.W.P., threaded ends.
- B. Up to and including 2 inches:
 - 1. Manufacturers:
 - a. Nibco-Scott; Product KT-65.
 - b. Kennedy; Product 97SD.
 - c. United; Product 125S.
 - d. Fairbanks; Product 4691-3.

2.6 ANGLE VALVES

- A. Bronze body, rubber disc, union bonnet, 174 non-shock cold water, threaded ends.
- B. Up to and including 2 inches:
 - 1. Manufacturers:

- a. Nibco-Scott; Product T-301-W.
- b. Kennedy; Product 985D.
- c. United; Product 126S.
- d. Fairbanks; Product 4691-3.

2.7 CHECK VALVES

- A. Iron body, U.L. Listed- F.M. Approved, swing type, bronze trimmed, bronze seat and disc, flanged or grooved ends.
- B. Manufacturers:
 1. Crane
 2. Stockham
 3. Mueller
 4. Kennedy
 5. Victaulic

2.8 BUTTERFLY VALVES 2 1/2" AND LARGER:

- A. Gear operated, cast iron body, wafer design type body, U.L. Listed - F.M. approved, with resilient seat, self-sealing between companion flanges, 175 pound W.O.G.
- B. Manufacturers:
 1. Grinnell Series 8000FP.
 2. Nibco WD3510 Series.
 3. Mueller B-3250-00.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Storage: All piping shall be stored above ground and protected to prevent dirt and debris from entering pipe.

3.2 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13 and these specifications.
- B. Install post indicator valve (PIV) downstream of backflow device.

- C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- D. Install piping to conserve building space, to not interfere with use of space and other work.
- E. Group piping whenever practical at common elevations.
- F. All piping shall be installed above ceilings in a concealed manner except where no ceilings are present
- G. Sleeve pipes passing through partitions, walls, and floors.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Reducing Tees: Weld-on threaded outlet tees and Coupolet-300 by Bonney Forge Division of Energy Products Group, Central Sprink 701, "TEE-LET" 300 by Merit Manufacturing Corp., NAP300 by North Alabama Pipe Corp., F400 by Grinnell Corp. may be used for side outlet reducing tees more than two pipe sizes smaller than main. Discs shall be retrieved and connected to pipe at point of cutting. Cutting shall comply with NFPA 13, Chapter 6.5.2.4.8.
- J. Couplings may be used on gridded systems at only one end of each gridded branch line or on 2" or larger riser nipple to a 1 1/2" or smaller branch line to facilitate connection provided that the coupling is connected to piping by a cut groove in schedule 40 piping.
- K. Pipe Hangers and Supports:
 - 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Hangers when pressure exceeds 100psi:
 - a. Provide surge clips or extend threaded rod to prevent upward movement on the end sprinkler head, Refer to NFPA 13 Figure A.9.2.3.4.4.
 - b. The unsupported armover length and unsupported branchline length shall not exceed 12" for end sprinklers in the pendent position.
- L. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- M. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 9000.
- N. Do not penetrate building structural members unless indicated.

- O. Provide sleeves when penetrating floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- P. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- Q. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- R. Provide gate or butterfly valves for shut-off or isolating service. No valve shall be installed with the centerline, if horizontal, or wheel, if vertical, more than 9'-0" AFF.
- S. Provide drain valves at main shut-off valves, low points of piping and apparatus. Route drains to interior mop basins or exterior of building in locations acceptable to Design Professional.

3.3 CLEANING AND PROTECTION

- A. All materials, equipment and mechanical rooms shall be cleaned prior to the Final Observation.
- B. Wash down and scrub clean all mechanical room floors, walls, equipment bases and equipment.
- C. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish.
- D. Chipped or scraped paint shall be retouched to match original finish.
- E. All dents and sags in equipment casing shall be straightened.
- F. All equipment, pipe, pipe fittings and appurtenances shall be free of rust and stains prior to substantial completion.

3.4 FINISHING EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint shop-primed equipment and piping, in utility areas in colors according to the color coding scheme indicated.
- C. Re-install electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- D. Paint all exposed pipes, unless otherwise indicated.
- E. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish shall be painted to prevent rust.
- F. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.

- G. Paint all exposed un-insulated ferrous materials.

END OF SECTION 21 1100

SECTION 21 1200 - FIRE-SUPPRESSION STANDPIPES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire hose cabinets.
- B. Valves.

1.2 RELATED REQUIREMENTS

- A. Section 21 0510 - General Fire Suppression Requirements.
- B. Section 21 1100 - Fire Suppression Piping.
- C. Section 21 1300 - Fire-Suppression Sprinkler Systems.
- D. Section 21 3000 - Fire Pumps.

1.3 REFERENCE STANDARDS

- A. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; National Fire Protection Association; 2019.
- B. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2017.
- C. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; 2018.
- D. Georgia State Minimum Standard Fire Prevention Code, 2018 Edition, with all Georgia State Amendments.
- E. Chapter 120-3-3 of the Rules of the Safety Fire Commissioner dated January 1, 2020.
- F. Georgia State Minimum Standard Building Code (International Building Code), 2018 Edition, with all Georgia State Amendments. NFPA Code, where more stringent, shall take precedence.

1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories.
- B. Shop Drawings: Indicate supports, components, accessories, and sizes.
 - 1. Submit shop drawings and product data to Fire Marshal for approval and to the Design Professional for review. Submit to the Design Professional prior to

submitting to the Fire Marshal. Submit proof of approval to Design Professional. Install no piping until receipt of approved shop drawings from the State Fire Marshal.

2. Submit proof of approval to Architect.

C. Project Record Documents: Record actual locations of components.

D. Operation Data: Include appropriate manufacturer's data.

E. Maintenance Data: Include servicing requirements and test schedule.

F. Certificates: Provide certificate of compliance indicating approval of field acceptance tests.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in shipping packaging until installation. Store piping off ground and cover to prevent dirt and debris from entering piping.

PART 2 PRODUCTS

2.1 VALVES

A. Hose Connection Valve: Angle type; brass finish; 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of same material and finish; refer to Section 21 0500.

B. Pressure Reducing Valve: Angle type; brass finish with inner hydraulic controls; 1-1/2 inch size, thread to match fire department hardware, 400 psi inlet pressure, with threaded cap and chain of same material and finish; refer to Section 21 0500.

C. Hose Connection Valve Cabinets:

1. Style: Recessed mounted.

2. Tub: 16 gage, 0.0598 inch thick steel, prepared for pipe and accessory rough-in.

3. Door: 12 gage, 0.1046 inch thick steel, flush, glazed with 1/4 inch (6.35 mm) thick wired glass full panel; hinged, positive latch device.

4. Finish: Prime coated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 14.

C. Locate and secure cabinets plumb and level. Establish top of cabinet (inside horizontal) surface 60 inches above finished floor.

D. Connect standpipe system to water source ahead of domestic water connection.

- E. Where static pressure exceeds 175 psi but is less than 350 psi at any fire valve cabinet, provide pressure reducing valve on hose connection valve to prevent pressure from exceeding 175 psi.
- F. Provide two way fire department outlet connection on roof.
- G. Flush entire system of foreign matter.

3.2 FIELD QUALITY CONTROL

- A. Test entire system in accordance with NFPA 14.

END OF SECTION 21 1200

SECTION 21 1300 - FIRE SUPPRESSION SPRINKLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wet Type Sprinkler System
- B. System design, installation, and certification.
- C. Fire department connections.

1.2 RELATED REQUIREMENTS

- A. Section 28 3100 - Fire Alarm Systems.
- B. Section 21 0510 - General Fire Suppression Requirements
- C. Section 21 1100 - Fire Suppression Piping: Pipe, fittings, and valves.
- D. Section 21 3000 - Fire Pumps.
- E. Section 26 2717 - Equipment Wiring:

1.3 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide; current edition.
- B. FM (AG) - FM Approval Guide; Factory Mutual Research Corporation; current edition.
- C. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2019.
- D. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; National Fire Protection Association; 2019.
- E. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems; 2017.
- F. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.4 SUBMITTALS

- A. See Section 21 0510 - General Fire Suppression Requirements for submittal procedures.
- B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

- C. Shop Drawings:
 - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
 - 3. Submit shop drawings, product data, and hydraulic calculations to Fire Marshall for approval and to Architect for review. Submit to Architect prior to submitting to Fire Marshal. Submit proof of approval to Architect. Install no piping until receipt of approved shop drawings from the State Fire Marshal.

- D. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations. Provide two (2) CD and three (3) paper copies of as-built drawings. CD's shall be in Autocad release 14 or later or in microstation V8 format.

- E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements. All certificates shall be signed by certificate holder.

- F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
 - 3. Sprinkler Wrenches: For each sprinkler type.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
- B. Comply with FM (AG) requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- D. Equipment and Components: Provide products that bear FM (AG) label or marking.
- E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
- B. Store piping off floor and out of elements. Provide cover for piping to prevent dirt and debris from entering piping. Piping and fittings shall be rust free when installed.

1.7 EXTRA MATERIALS

- A. Provide extra sprinklers of type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
- B. Provide suitable wrenches for each sprinkler type.
- C. Provide metal storage cabinet located at piping entrance to building.

PART 2 PRODUCTS

2.1 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for entire building.
- B. Occupancy is primarily: Light hazard; comply with NFPA 13.
- C. Water Supply: Contractor shall perform or have performed an NFPA-13 water flow test and a 24 hour static pressure test. Adjust flow test to lowest pressure recorded by 24 hour test of one hour duration.
- D. Interface system with building fire alarm system.
- E. Provide fire department connections where indicated.
- F. Storage Cabinet for Spare Sprinklers and Tools: Steel, in the fire pump room.

2.2 SPRINKLERS

- A. Tyco and affiliates, Victaulic, Viking, Reliable, Globe, and Grinnell.
- B. All sprinklers installed shall be by the same manufacturer.
- C. Contractor shall select temperature ratings in accordance with NFPA 13.
- D. Extended coverage sprinklers shall NOT be used except where shown on contract drawings.
- E. Suspended Ceiling Type: Semi-recessed pendant type with matching flush push on two piece escutcheon plate.
 - 1. Finish: Chrome plated.
 - 2. Escutcheon Plate Finish: Chrome plated.
 - 3. Fusible Link: Quick response Glass bulb type temperature rated for specific area hazard.
 - 4. Orifice: 1/2".
- F. Gypsum Board Ceiling Type: Concealed pendant type with matching push on escutcheon plate.
 - 1. Cover plate Finish: White
- G. Exposed Area Type: Standard upright type .

1. Finish: Brass.
2. Fusible Link: Quick Response Glass bulb type temperature rated for specific area hazard.
3. Orifice: 1/2".

H. Sidewall Type: Standard horizontal sidewall type with matching flush push on two piece escutcheon plate .

1. Finish: Chrome plated.
2. Escutcheon Plate Finish: Chrome plated.
3. Fusible Link: Quick Response Glass bulb type temperature rated for specific area hazard.
4. Orifice: 1/2".

2.3 PIPING SPECIALTIES

A. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC. Notifier, Simplex, Potter, Grinnell.

B. Tamper Switch: Switch designed for installation on indicator valves with cased aluminum housing with red finish. Notifier, Simplex, Potter, Grinnell.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard and these specifications.
- B. Install sprinklers where shown on contract drawings. Sprinklers in gypsum board ceilings shall be in line with and centered between down lights unless shown otherwise.
- C. Install equipment in accordance with manufacturer's instructions.
- D. Each floor of multi-story buildings shall be zoned except as noted on contract drawings.
- E. Provide approved double detector check assembly at sprinkler system water source connection.
- F. Locate wall mounted fire department connection not less than hundred (100'-0") feet not more than fifty(50'-0") from a fire hydrant and with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle. Refer to location shown on drawings.
- G. Place pipe runs to minimize obstruction to other work.
- H. Place piping in concealed spaces above finished ceilings.
- I. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

- J. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- K. Flush entire piping system of foreign matter.
- L. Hydrostatically test entire system.
- M. All drain piping shall discharge to the outside 6" maximum above grade unless noted otherwise.
- N. Where sprinklers are required under oval or round duct, the centerline of the sprinkler shall be under the centerline of the duct.
- O. Where sprinklers are required under rectangular duct, the centerline of the sprinkler shall be minimum 6" under duct.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required tamper and flow devices are installed and connected as required to fire alarm system including but not limited to floor control valves, post indicator valves (PIV), backflow device valves, and fire and jockey pump valves.

3.3 SCHEDULES

- A. System Hazard Areas:
 - 1. Offices: Light Hazard.
 - 2. Mechanical/ Electrical, Closets, Storage Rooms, Work Rooms: Ordinary Hazard, Group 1.
 - 3. Classrooms, Corridors, Lobbies, Vestibules, Gyms: Light Hazard.
 - 4. Laboratory Areas (Chemistry and Flex Labs): Ordinary Hazard, Group 1.

END OF SECTION 21 1300

SECTION 21 3000 - FIRE PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire pump, electric motor drive, controller, and accessories.
- B. Electric jockey pump.

1.2 RELATED REQUIREMENTS

- A. Section 21 0510 - General Fire Suppression Requirements
- B. Section 21 1100 - Fire Suppression Piping.
- C. Section 21 1200 - Fire Suppression Standpipes.
- D. Section 21 1300 - Fire Suppression Sprinklers.

1.3 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide; Factory Mutual Research Corporation; current edition.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2019.
- D. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; National Fire Protection Association, 2019.
- E. NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection; 2019
- F. NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2017.
- G. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
- H. UL 448 - Centrifugal Stationary Pumps for Fire-Protection Service; Current Edition, Including All Revisions.
- I. UL 1478 - Fire Pump Relief Valves; Current Edition, Including All Revisions.
- J. Rules of Safety Fire Commissioner, 120-3-3, dated January 1st. 2020.

1.4 SUBMITTALS

- A. See Section 21 0510 - General Fire Suppression Requirements for submittal procedures.

- B. Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.
- C. Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.
- D. Test Reports: Indicate results of hydrostatic test and field acceptance tests.
- E. Manufacturer's Instructions: Indicate support details, connection requirements, for fire pump system.
- F. Project Record Documents: Record actual locations of components and accessories.
- G. Certificates: Certify that fire pumps meet or exceed specified requirements at specified operating conditions and that the installation complies with regulatory requirements. Submit summary and results of shop tests performed in accordance with NFPA 20.
- H. Operation Data: Include manufacturer's instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.
- I. Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 13 and NFPA 20; where requirements differ comply with the most stringent.
- B. Perform Work in accordance with NFPA 20 .
- C. Equipment and Components: Bearing FM (AG) label or marking.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- E. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- F. Manufacturer's Factory Tests: Each individual pump shall be hydrostatically tested and run tested prior to shipment. The pump shall be hydrostatically tested at a pressure of not less than one and one-half times the no flow (shut off) head of the pumps maximum diameter impeller plus the maximum allowable suction head but in case less than 250 psig.
- G. Provide certificate of compliance indicating approval of field acceptance tests.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fire pumps and components in factory packing. Comply with manufacturer's rigging and installation instructions.
- B. Protect fire pumps and components from physical damage including effects of weather, water, and construction debris.
- C. Provide temporary inlet and outlet caps, and maintain in place until installation.

PART 2 PRODUCTS

2.1 FIRE PUMPS

- A. Horizontal base-mounted type; UL 448 and FM approved ; horizontal shaft, single stage, double suction, direct connected, horizontally split casing, for 250 psi minimum working pressure.
 - 1. Casing: Cast iron, with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
 - 2. Impeller: Bronze double suction fully enclosed, balanced and keyed to shaft.
 - 3. Bearings: Grease lubricated ball bearings, replaceable without opening casing.
 - 4. Shaft: Alloy steel with replaceable bronze shaft sleeve.
 - 5. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 230 degrees F maximum continuous operating temperature.
 - 6. Drive: Flexible coupling with coupling guard.
 - 7. Performance:
 - a. Flow: 1,000 gpm, at 92 feet head.
 - b. Motor: 30 hp, 460 volt, single phase, 60 Hz.
- B. Accessories:
 - 1. Eccentric suction reducer and OS&Y gate valve on suction side of pump.
 - 2. Concentric increaser and check valve in pump discharge and OS&Y gate valve on system side of check valve.
 - 3. Fire pump bypass fitted with OS&Y gate valves and check valve.
 - 4. Main relief valve, if required, UL 1478, and enclosed type waste cone. Pipe to outside.
 - 5. Suction pressure gauge, 4-1/2 inch diameter dial with snubber, valve cock and lever handle.
 - 6. Discharge pressure gauge mounted on board attached to pump, with snubber, valve cock and lever handle.
 - 7. 3/4 inch casing relief valve.
 - 8. Float operated 3/4 inch automatic air release valve.
 - 9. Test valve manifold with 2-1/2 inch hose gate valves with caps and chains. Locate valves inside building.
 - 10. Flow metering system for closed loop testing.
- C. Fire Pump Test Connection: 4 x 2-1/2" supplied by a 6" pipe, polished chrome on exposed parts, flush mounting with polished chrome plate lettered "Pump Test

Connection". Chrome Plated 2-1/2" hose valves, polished brass cap and chain. Provide and locate in line O.S.& Y gate valve for hose valve headers inside the building.

1. Manufacturers:
 - a. Elkhart
 - b. Croker
 - c. Potter-Roemer

2.2 FIRE PUMP CONTROLLER

- A. Controller: Digital solid state starter with soft start and soft stop, in NEMA 2 enclosure, including the following:
 1. Disconnect Switch: Externally operable, quick break type.
 2. Circuit Breaker: Comply with NFPA 20; minimum 100,000 amperes interrupting capacity.
 - a. The controller shall be capable of interrupting a short circuit current at least equal to the available short circuit current in the controller supply circuit.
 - b. This fire pump controller installation requires an withstand rating of not less than 100,000 amps RMS symmetrical at an operating voltage of 480 Volts.
 3. Provide a Surge Protective Device integral to the controller. Refer to Section 26 2417 – Surge Protective Devices for specific ratings and surge level requirements.
 4. Motor Starter: Energized automatically through pressure switch or manually by externally operable handle.
 5. Pressure Switch: Set to cut in at manufacturers recommended psi.
 6. Running Period Timer: Keeps motor in operation when started automatically, for a minimum of seven minutes.
 7. Pilot Lamp: Indicates circuit breaker closed and power available.
 8. Test Accessories: Ammeter test link and voltmeter test studs.
 9. Alarm Relay: Energizes alarm to indicate circuit breaker open or power failure.
 10. Switch Relay: For remote start.

2.3 PRESSURE BOOSTER (JOCKEY) PUMP

- A. Manufacturers:
 1. Peerless
 2. Patterson
 3. Allis Chalmers
 4. Armstrong
 5. Aurora
 6. Fairbanks Morse
 7. Grundfos
- B. Capacity: 10 GPM at 50 PSI TDH with 1 HP motor for 3500 RPM.
- C. Electrically operated, horizontal turbine type with standard open drip-proof horizontal motor.
- D. Control by automatic jockey pump controller with full voltage starter and minimum run timer to start pump on pressure drop in system and stay in operation for minimum period

of time. Fire pump shall start automatically on further pressure drop or on jockey pump failure.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 20.
- B. Provide access space around pumps for service; no less than minimum as recommended by manufacturer. Provide clearance in accordance with NEC for Controllers.
- C. Install piping in accordance with Section 21 1100. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base mounted pumps, provide supports under elbows on pump suction and discharge.
- D. Provide drains for bases and seals, piped to and discharging to floor drain.
- E. Provide for connection to electrical service. Refer to Section 26 2717.
- F. Lubricate pumps before start-up.
- G. Check, align, and certify pumps by qualified installer prior to start-up.

3.2 FIELD QUALITY CONTROL

- A. Perform hydrostatic tests, flushing, and field acceptance tests as specified in NFPA 20.

END OF SECTION 21 3000

SECTION 22 0510 - GENERAL PLUMBING REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Definitions
- B. Assurance Requirements and Installer Qualifications.
- C. Submittal Procedures Supplementing Section 01 3000.
- D. Operating and Maintenance Manuals
- E. Execution Requirements common to Division 22 systems
- F. Mechanical sleeve seals.
- G. Pipe Sleeves within building
- H. Pipe Sleeves in footings and foundations
- I. Piping Pressure Tests.
- J. Equipment bases and housekeeping pads
- K. Training Requirements
- L. Cleaning Requirements.
- M. Finishing Requirements

1.2 RELATED SECTIONS

- A. Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Section 01 7700 - Closeout Procedures, for additional submittal and warranty requirements.
- C. Section 03 3000 - Cast-in-Place Concrete.
- D. Section 07 8400 - Firestopping.
- E. Section 07 9200 - Joint Sealants
- F. Section 09 9100 - Painting.

1.3 DEFINITIONS

- A. **Manufacturer's Representatives:** Wherever MANUFACTURER'S REPRESENTATIVE is referred to in this division, said representative shall be regularly employed by the manufacturer to perform similar activities to those called for herein, which indicates his competence in that field of work.
- B. **Concealed:** Where the word concealed is used in this Division, it shall mean items above ceilings, in attics, in crawl spaces, in chases, in tunnels, in cabinet work, and under counters or equipment so as to be not visible from an elevation of 5 feet at a horizontal distance of 10 feet.
- C. **Finished Spaces or Areas:** Where finished spaces or areas are referred to in this Division, it shall mean all spaces except concealed spaces, mechanical rooms, or boiler rooms unless otherwise noted.
- D. **Provide:** Furnish and install.
- E. **Control and Interlock Wiring:** All wiring, both line voltage and low voltage, other than power wiring from an electrical distribution panel, through the primary control device, to the item of equipment.
- F. **Primary Control Device:** That ONE device for any item of equipment which interrupts power flow during normal operation. Where magnetic starters are provided, they are the primary control. For items not switches by starters, the primary control device will be that ONE thermostat, time clock, manual switch, aquastat, or relay performing the primary switching.
- G. **Diagrammatic:** A drawing that shows arrangement and relations (as of parts).i.e.: A diagrammatic drawing uses symbols rather than pictorial representation of pipes and other items shown and is not necessarily to scale. Arrangement, location, and sizes shown are firm.
- H. **Readily Accessible:** Equipment, valves and other items requiring service shall be installed to be readily accessible. These items shall be available for maintenance or use in a space, through an access door from floor elevation, or above a lay-in ceiling by maintenance staff standing on a ladder no taller than the ceiling.
- I. **Noted, Indicated or Shown:** Where the terms "Noted", "Indicated" or "Shown" are used in these specifications, the words "in the specifications or on the plans" shall be inferred.
- J. **Detail:** Where reference is made to a Detail, the Detail shall be on the plans unless otherwise noted.
- K. **Specifications:** Where reference is made to these specifications, it shall be inferred in this Division of specifications.
- L. **Notification by the Contractor, and Instructions to the Contractor:** Where reference is made in these specifications to notification by or instructions given to the Contractor, it shall be inferred that Architect shall be the instructor or shall be notified, as the case exists.

- M. Division or Section Reference: Where reference is made to another Division or Section within this Division, refer to specifications table of contents for Division, Section, or Page Number.
- N. Flow Diagram: A single-line, two-dimension, non-scaled drawing depicting arrangement and sequence of equipment, valves, controls, thermometers, gauges, and other specialty devices in a pipe system.

1.4 REGULATORY REQUIREMENTS

- A. Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications.
- B. Materials and equipment included in Underwriters Label Service shall bear that label. Electrical equipment shall be U.L. approved as installed.
- C. Jurisdiction: Where codes or guides refer jurisdiction to local governing code officials, such official in this procedure shall be the State Fire Marshal.
- D. Permits: Obtain all permits, paying all fees in connection therewith. At completion, have work inspected by proper authorities and furnish Architect for Owner an inspection certificate showing approval of installation.
- E. Plumbing: Conform to the International Plumbing Code, 2018 Edition, with all Georgia State Amendments.
- F. Fire Prevention Precautions in Cutting and Welding Areas: Conform to Article 2605 Fire Prevention Precautions, Georgia State Minimum Standard Fire Prevention Code (International Fire Code), 2018 Edition, with all Georgia State Amendments, for all work involving cutting and welding.
- G. Gas: Conform to the International Fuel Gas Code, 2018 Edition, with all Georgia State Amendments.
- H. Energy: Conform to the International Energy Conservation Code, 2015 Edition, with all Georgia State Amendments.
- I. All Work: Conform to State of Georgia Chapter 120-3-3 "Rules of Safety Fire Commissioner, Rules and Regulations, January 1st, 2020".
- J. All Work: Conform to State of Georgia Chapter 120-3-20 "Access To and Use of Public Facilities by Handicapped Persons" and 2010 ADA Standards for Accessible Design.
- K. Electrical: Refer to Division 26. Conform to the National Electrical Code, NFPA 70, 2017.
- L. Building Code: Conform to the International Building Code, 2018 Edition with all Georgia State Amendments.

1.5 PERFORMANCE REQUIREMENTS

- A. Requirements specified herein are minimum. All equipment, when installed, shall perform equal to or exceed specified requirements.

1.6 VALUE ENGINEERING

- A. Where the Contractor is requested to offer or make Value Engineering suggestions as a means of reducing the Project Cost, the Contractor shall present suggestion in the format prescribed herein.
- B. Provide each suggestion in writing referencing the specific element involved, i.e. specification article and/or drawing/detail number(s).
- C. State how the proposed change impacts the project, i.e. change in life expectancy, increased operating costs, etc. in addition to the reduction of first cost (Amount of cost reduction.).
- D. State how the change will impact the Construction Schedule.
- E. Where the change impacts the contract drawing(s), provide a sketch of the proposed change to assist in the evaluation process. If the suggestion is approved, the Contractor shall provide a drawing, as a part of the shop drawing process, showing the Contractor's proposed changes.
- F. Each suggestion shall include specific language commenting that the proposed change has been or has not been successfully made previously one or more similar projects.

1.7 SUBMITTALS

- A. Refer to Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Supplementing Division 1 requirements; Contractor shall:
 - 1. Review the submittal data and check to ensure compliance with specifications prior to submitting.
 - a. The Contractor agrees that submittals of equipment and material and shop drawings of equipment and material layouts required under provisions of these specifications and processed by Architect are not Change Orders. The purpose of submittals is to demonstrate that Contractor understands the design concept of the project by indicating the equipment and materials he intends to furnish and install, and by detailing the installation he intends to achieve.
 - b. The Contractor shall conform to the requirements of the Contract Documents unless a change order is issued. The Contractor shall identify on each submittal and letter form to the Design Professional any and all deviations from the Contract Documents.
 - c. Any submittal or shop drawing not conforming to the Contract Documents without this identification and notification shall be assumed to be marked "Revise and Resubmit" (acknowledges this by the submission), and Contractor shall promptly resubmit said submittal so as to be in full compliance with the Contract Documents.

- d. Failure of Contractor to provide this information during the shop drawing phase shall make Contractor responsible for all changes to achieve compliance with the Contract Documents without additional compensation.
2. Assemble the submittal data in compete sets in hard back three-ring binders, separate binders, and bound with numbered index sheets and tabs. All submittal data shall be submitted at one time unless unavailable data would delay project progress. Data shall include capacities, complete installation instructions, dimensional data and electrical data, BHP, motor HP, operating weights and load distribution at mounting points. Any submittals sent in pieces or not secured in a three ring binder will be marked not reviewed and will be returned to the contractor.
3. Identify all submittals by a cover sheet showing project name, specification sections, drawing or detail number, room number, date, revision date, contractor and subcontractor's organization and project manager with phone number, the model, style and size of item being submitted with manufacturers' representative, salesman (or a preparer who can answer questions), and Preparer's phone number.
4. Manufacturers' standard drawings shall be modified by deletions or additions to show only items applicable to this project.
5. Prepare a master list of submittal proposed to be submitted on the project. This list shall be updated for each submission and shall be the first sheet(s) of the submission in the quantity that is submitted for review. The information and general format shall contain an Tab number, Item Description, Item Status and any comment.
6. Provide a Letter stating that all submittals have been checked for compliance with specifications.
7. Deliver submittals to the Design Professional at the business address.
8. Electronic Delivery of Submittals:
 - a. Submittal data may be posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Construction Manager will be provided with a project folder and password.
 - b. Prepare the submittals as described above in Sections 1.7.A.1-7. Provide one pdf file for each specification section including all submittal data for that specification section. Provide labels identifying each piece of equipment, piping, or accessory to match the listed item in the specification. Take steps to reduce submittal file size.
 - c. Do not scan in color or high resolution unless needed for clarity.
 - d. Ensure any reproductions are legible.
 - e. Send an email to submittal@nbpengineers.com with a copy to the Plumbing Design Professional and the Architectural Design Professional (if applicable) identified during the preconstruction phase.
 - f. Provide a submittal index and identify the submittal in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx. Addition to Administrative Building - Section 22 0519 - Meters and Gages for Plumbing Piping.
 - g. Each pdf should include bookmarks to each product, and specification section to easily navigate the pdf file.
 - h. Ensure the submittal posted to the FTP site has the same identification.
 - i. NBP Design Professionals will not process or react to submittals which are not properly transmitted, indexed, and identified.

- C. Product Data:
 - 1. Provide data specific to the Product proposed indicating capacity data, all standard and optional features to be supplied and all accessories and options available for that product.
 - 2. Manufacturer's standard drawings shall be modified by deletions or additions to show only items applicable to this project.
- D. Piping Pressure Tests - Submit the following:
 - 1. Hydrostatic Testing Records: The Contractor shall maintain an updated log of pressure tests (as described in this Section) available to the Owner and Design Professional at all times. The Contractor shall submit a final log to the Owner for record.
- E. Warranty: Submit Contractor's warranty letter addressed to Owner stating the correct project name and number, if applicable, the warranty period and ensure that form has the correct date of Material Completion.

1.8 OPERATING AND MAINTENANCE MANUALS

- A. Operating and Maintenance Manuals shall be prepared by the Contractor for all equipment and be submitted for review a minimum of prior to the request for Material Completion.
- B. Digital delivery of Operating and Maintenance Manuals:
 - 1. Operating and Maintenance Manuals may be delivered digitally and posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and password.
 - 2. Prepare the Operating and Maintenance Manuals as described above. Take steps to reduce submittal file size.
 - 3. Do not scan in color or high resolution unless required for clarity.
 - 4. Ensure any reproductions are legible.
 - 5. Send an email to submittal@nbpengineers.com with a copy to the Plumbing Design Professional and the Architectural Design Professional (if applicable) identified during the preconstruction phase.
 - 6. Identify the manuals in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building.
 - 7. Table of Contents(Index) sheets shall be included in the order listed with identifications typed in capital letters.
 - 8. Ensure the manuals posted to the FTP site has the same identification.
 - 9. The O&M Pdf should contain bookmarks to each section of the manual, and bookmarks to each product.
 - 10. NBP Design Professionals will not process or react to manuals which are not properly transmitted, indexed, and identified.
- C. Each Manual shall contain the following information, data and drawings:
 - 1. Copies of submittals (with Design Professional's review comments and stamp), equipment and materials.

2. Manufacturer's installation, operating and maintenance instructions for each item of equipment with moving parts including recommended frequency of inspections and maintenance for one year of facility operation.
3. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
4. Copies of as-built shop drawings showing layouts and construction details.
5. Digital copies of the Piping Integrity Testing Videos.

1.9 QUALITY ASSURANCE

A. Plumbing Installer Qualifications:

1. Wherever the word "company" or "firm" is used in these subparagraphs, it shall mean the contractor/subcontractor of record for the installations used for proficiency qualification.
2. Refer to the individual sections within this division for additional installer qualification requirements.
3. The Contractor expressly warrants that the company performing the installation of the plumbing systems has demonstrated proficiency in the installation and adjustment of such systems by the successful performance of work of the nature specified herein on at least three commercial or institutional buildings, each containing water heating systems, pumping systems(i.e. hot water recirculation, sump pumps, or pressure booster pumps), and a minimum of 10 plumbing fixtures.
4. The Contractor also warrants that the aforesaid installer, if any, has been in business performing services of the nature specified herein for at least three(3) years.

1.10 PRODUCT DELIVERY, STORAGE, AND PROTECTION

- A. Accept all products on site in factory-fabricated protective containers. Inspect for damage.
- B. Store products in a clean dry place and protect from weather and construction traffic.
- C. Handle products carefully to avoid damage to components, enclosures, and finish.
- D. After placement, protect products from damage during construction, by all trade contractors.
- E. Protect equipment nameplates and labels from damage, being painted, scaring, etc.

1.11 WARRANTY

- A. Refer to Section 01 7700 - Closeout Procedure, for additional warranty requirements.
- B. Where extended warranties beyond Contractor's one (1) year warranty are specified, the additional warranty time shall start at the end of Contractor's warranty.
- C. Correct defective Work within a one year period after Date of Material Completion.

PART 2 PRODUCTS-NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

A. Hazardous Materials:

1. A/E's Responsibility: Plans and specifications have been prepared by the A/E for Owner without the A/E having conducted investigation as to the presence of asbestos or hazardous waste on the project. Not being a part of this contract, the A/E has not charged any fees and has not and will not advise Owner with regard to the detection and/or removal of asbestos or hazardous waste. Owner is aware that asbestos or hazardous waste could be present and will make all decisions with regard to its removal. The removal of all hazardous materials and encapsulation of remaining surfaces is the sole responsibility of Owner.
2. If Contractor observes the existence of a friable material which must be disturbed during the course of his work, Contractor shall promptly notify Owner and Architect. Owner shall make all arrangements regarding testing and removal or encapsulation of asbestos material if present. Contractor shall not perform any work pertinent to the friable material prior to receipt of special instructions from Owner through Architect.
3. "Friable Material" is any material which can be crumbled, pulverized or reduced to a powder by hand pressure when dry.

B. Refer to the specifications and Architectural and Structural drawings for additional requirements pertaining to work under this discipline. Notify Architect for clarification in the event of conflict.

C. All materials of systems installation exposed in hollow spaces that are used as ducts or plenums shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less.

3.2 PREPARATION

A. Drawings are diagrammatic and show the general proximity of the equipment and pipes. They are not to be scaled, and do not include all required changes in direction or offsets necessary in coordinating the installation of various materials either between trades or within the same trade. All dimensions shall be verified at the building site. Prefabrication and/or installation of work from drawings shall be at Contractor's risk. Refer to Architectural plans for exact building dimensions and details.

B. Space Conditions:

1. All apparatus shall fit into the available spaces in the building and must be introduced into the building so as not to cause damage to the structure. Equipment larger than access to equipment spaces shall be disassembled into sub-assemblies for installation.
2. Where deviations from the plans are required in order to conform to the space limitations, such changes shall be made at no additional cost to Owner and shall be subject to approval.

3. All equipment requiring service shall be made accessible. Coordinate piping installation to avoid conflict with other trades.
- C. Where new work is specified tying into old work and materials are different from existing, the contractor shall request a clarification from Architect prior to performing the work.
- D. Where sanitary drainage systems or storm drainage systems are to be reused in existing buildings. The contractor shall camera all existing piping below slab that is to be reused to verify the piping is the correct size, the piping is sloped in the correct direction, the pipe is not broken or damaged, and the piping is free of obstructions. The contractor shall notify the design professional of any deficiencies prior to performing any work.

3.3 DEMOLITION

- A. Drawings showing existing building conditions and utilities are based on casual field observation and existing record documents only.
 1. Verify that construction and utility arrangements are as shown.
 2. Report discrepancies to the Architect before disturbing existing installation.
 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. The demolition plans have been prepared to assist the contractor in determining the scope of demolition work and should not be construed to be all of the demolition required. The contractor shall visit job site (after carefully reviewing the contract documents) and determine exact areas and quantities of existing materials to be removed to accomplish new construction.
- C. All existing equipment and material removed from the facility shall be the property of the Contractor, unless otherwise noted, and shall be removed from the facility as required by the Contract provisions concerning trash removal.
- D. Where the Documents indicate an equipment item to be removed. Remove all associated material including hangers, supports, etc. Do not leave abandoned items.
- E. Remove exposed and accessible piping, and other materials rendered useless due to changes or modifications. Cap outlets in piping. Repair piping insulation damaged during construction.
- F. Remove concealed piping which is exposed by the removal of walls, partitions, etc., and reconnect and re-route as required to maintain system continuity.
- G. Sleeves left open by removal of piping shall be cut flush with the finished slab or wall, filled with non-shrinking cement grout and/or fire rated foam flush with both sides of slab or wall to maintain slab or wall fire rating.
- H. Material and equipment which has been removed shall not be used in the new work, except as noted.
- I. Where existing piping and/or equipment is shown on the Drawings, its size and location shall be verified prior to performing any work relating to demolition. Notify Architect of any discrepancies.

- J. Dispose of any material to be discarded in accordance with all laws and regulations.
- K. Comply with all other applicable requirements of this Section and related Sections of the project manual.

3.4 INSTALLATION

- A. Clearance above and in front of electrical switchgear, electrical power panels or control panels shall be maintained by mechanical systems so that no pipes, vents, or equipment is routed above or across the space directly above this equipment in conformance with the National Electrical Code.
- B. All equipment shall be installed in accordance with manufacturers' published installation instructions shipped with the equipment. In the event there is a discrepancy between these specifications or Drawings and the manufacturers' instructions, no work shall be performed until additional instructions are received.
- C. Install and connect all appliances, equipment, and appurtenances as specified, indicated or required in accordance with the manufacturer's instructions and recommendations. Furnish and install complete auxiliary piping, water seals, valves, electric connections, and similar items, recommended by the manufacturer or as required for proper operation.
- D. Provide equipment coupling guards shielding the perimeter and face of all new shafts and couplings. Provide openings opposite drive shafts to permit use of revolution counter.
- E. Route piping to avoid skylights, translucent, and transparent ceilings.
- F. Pipe Sleeves in Slabs, Masonry Walls and Partitions:
 - 1. Provide sleeves in all slabs and walls/partitions unless otherwise noted.
 - 2. Omit sleeves on cast iron pipe through slabs on grade.
 - 3. Provide sleeve seals where pipe passes thru building wall to a below grade location.
 - 4. Elevated Slabs: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a slab. Provide 4" high concrete curb around piping penetrating mechanical penthouse floor slabs.
 - 5. Masonry Partitions: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated masonry wall/partition.
 - 6. Omit sleeves in openings core drilled in masonry partitions.
 - 7. Rated Drywall Partitions: Schedule 40 black steel pipe. Sleeves shall be sized to include the insulation with minimum gap around the insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated drywall wall/partition.
 - 8. Non-Rated Drywall Partitions: Omit sleeves.

- G. Pipe sleeves in footings and foundation walls:
 - 1. Schedule 40 black steel pipe.
 - 2. Water pipe, distribution piping, soil or waste pipe or building drain passing under a footing or through a foundation wall shall be installed in a pipe sleeve, two pipe sizes larger than the pipe passing through.
 - 3. Sleeves in walls to spaces below grade shall be provided with 10 gauge leak plates.
- H. Seal sleeves and openings in mechanical room walls, fire rated partitions, and floors above grade vaportight, watertight, or for smoke/fire protection as applicable. Refer to Section 07 2700- Firestopping.
- I. Seal sleeves and openings in exterior walls vaportight or watertight as applicable. Refer to Section 07 9200 - Joint Sealants.
- J. Provide sleeve seals at all exterior pipe penetrations, above and below grade. Comply with manufacturer's sizing recommendations for size of pipes penetrating wall.
- K. Equipment and pipe support upper attachments shall be 3" x 3" x 1/4" galvanized steel angles, minimum, spanning structural members unless noted otherwise. Provide inserts and bolts for supporting pipes and equipment from structural members.
- L. Saw cut or core drill openings in existing work for the installation of the plumbing system. Patching shall be performed by the trade whose work is cut. Contractor shall lay out and install his work ahead of the work of other trades wherever possible.

3.5 PIPING PRESSURE TESTS

- A. General:
 - 1. Provide 48 hours notification to Architect in advance of any test.
 - 2. Complete tests prior to insulating.
 - 3. Leaks shall be repaired, defective materials replaced, and system shall be retested.
 - 4. Strike all joints in copper and steel piping under a pressure test.
 - 5. Conduct tests prior to connecting to equipment or isolate equipment from system.
 - 6. No water pressure test shall be conducted in freezing weather where subject to freezing.
 - 7. Test shall be maintained at conditions specified until approved but, in no event, for less than eight (8) hours minimum duration, unless otherwise noted.
 - 8. Hydrostatic pressure tests shall maintain pressure without change, except that due to temperature change.
- B. Domestic Water System: Hydrostatic test; 150 PSIG.
- C. Soil, Waste and Vent System: Static test; 10 feet minimum head. Test system in its entirety or in sections. Plug all openings except highest opening above the roof. Water shall be kept in the system, or in the portion under test, for a minimum of one (1) hour. Inspect the system, or the portion under test, after one (1) hour, the system shall be tight at all points.

- D. Storm Drain System: Static test; 10 feet minimum head. Test system in its entirety or in sections. Plug all openings except highest opening above the roof. Water shall be kept in the system, or in the portion under test, for a minimum of one (1) hour. Inspect the system, or the portion under test, after one (1) hour, the system shall be tight at all points.
- E. Multistory Buildings: Test tees shall be provided in soil, waste and storm drain piping to eliminate pressure testing of more than two floors at a time.
- F. Natural Gas System: Pressure test; 50 PSIG air or inert gas; 3 hours minimum duration. Oxygen shall not be used.
- G. Force Main Piping: Hydrostatic Test; 100 PSIG.
- H. Compressed Air System: To Pressure Reducing Stations: Pressure test; 150 PSIG air or inert gas; three hours minimum duration. Oxygen shall not be used.
- I. Vacuum System: 20-inch mercury; 3 hours minimum duration.
- J. Laboratory Gases: Before connecting to service outlets, pressure test systems to 150 PSIG using oil-free, dry air or nitrogen, 24 hours minimum duration.

3.6 EQUIPMENT BASES and HOUSEKEEPING PADS

- A. Provide housekeeping and equipment bases as shown or listed below. Rough up slab under bases before pouring concrete.
- B. Materials: Refer to Section 03 3000 - Cast-in-Place Concrete. Omit test cylinders for concrete poured under this section.
- C. Bases/Pads shall be rectangular with vertical sides 2 inches from edges of equipment, unless otherwise noted.
- D. Height:
 - 1. Water Heater: 4-inches.
 - 2. Concrete curb at all pipe penetrations of floors in mechanical rooms above grade: 4-inches or as shown on plans.
 - 3. Housekeeping Pads for Other Equipment: 4-inches or as shown on plans.
- E. Chamfer: 3/4-inch on edges and corners.
- F. Reinforcing: 6"x 6" 10/10 WWF at mid-depth of slab. (4 inch thick pads.)

3.7 STARTING EQUIPMENT AND SYSTEMS

- A. Adjust equipment for proper operation within manufacturers' published tolerances.
- B. Demonstrate proper operation of equipment to Owner 's designated representative.

3.8 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. Instruct operating personnel designated by the Using Agency in operation and maintenance of system prior to request for final inspection. Provide signed statement certifying instructions have been received.
- B. A manufacturer's service representative shall provide the instructions for each piece of equipment on system when specified in other Sections of this Division. A manufacturer's sales representative is not acceptable. (The instructor shall not be a sales person, but shall have service experience on a continuing basis and be knowledgeable about the subject equipment.)
- C. The Contractor shall give notice to Architect not less than 60 days of the anticipated date of instruction to allow planning by the Using Agency.
- D. The Contractor shall request the instruction date not less than 15 days of the desired date for coordination with the Using Agency. Operating manuals for the equipment/systems on which instructions are being given shall be in the possession of the operating personnel not less than 30 days prior to the date of instruction.
- E. The contractor shall give an orientation session to operating personnel for achieving familiarity (not instructions) of the systems approximately 5 days prior to the instruction date. The Contractor's representative giving instruction shall be knowledgeable in the equipment/systems to allow quality recordings by the Using Agency.
- F. The Contractor shall develop not less than three (3) copies of the instructions with an index for easy retrieval of information.

3.9 CLEANING and PROTECTION

- A. All materials, equipment and mechanical rooms shall be cleaned prior to Material Completion.
- B. Wash down and scrub clean all mechanical room floors, walls, equipment bases and equipment.
- C. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish.
- D. Chipped or scraped paint shall be retouched to match original finish.
- E. Clean and polish all equipment nameplates. All nameplate information shall be legible.
- F. All dents and sags in equipment casings shall be straightened.
- G. All insulation, equipment, pipe, pipe fittings and appurtenances shall be free of dust, rust and stains prior to Material Completion.

3.10 FINISHING PLUMBING EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint shop-primed equipment.
- C. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- D. Paint all exposed pipes, unless otherwise indicated.
- E. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish shall be painted to prevent rust.
- F. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.
- G. Paint all exposed un-insulated ferrous metals.

END OF SECTION 22 0510

SECTION 22 0519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pressure gauges and pressure gauge tapings.
- B. Thermometers and thermometer supports.

1.2 RELATED REQUIREMENTS

- A. Section 22 0510 - General Plumbing Requirements.
- B. Section 22 0719 - Plumbing Piping Insulation.

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.

1.4 SUBMITTALS

- A. Refer to Section - 22 0510 General Plumbing Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.1 PRESSURE GAUGES

- A. Manufacturer: Trerice Model 500X.
- B. Other acceptable manufacturers offering equivalent products: Duro 102, Marsh 103, Palmer 40SPDLH, Weksler BM1, Weiss AG-1.
- C. Gauge: ASME B40.1, UL 393 case, bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background and pulsation snubber.
 - 1. Size: 4-1/2 inch diameter.
 - 2. Mid-Scale Accuracy: One percent.
 - 3. Scale: Psi.

2.2 PRESSURE GAUGE TAPPINGS

- A. Ball Valve: 1/4 inch, 400 psig WOG, Bronze two piece body, standard port, chrome plated brass ball, reinforced teflon seats and stuffing box ring, blow-out proof stem design, adjustable packing gland, zinc coated steel lever handle with vinyl hand grip, threaded ends.

2.3 STEM TYPE THERMOMETERS

- A. Manufacturer: Trerice Model AX9.
- B. Other acceptable manufacturers offering equivalent products: Ashcroft 200-36E, Duro 7EZ3-6, Moeller 706AW, Palmer 9FLA, Weiss 7VS6, Weksler AA5.
- C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E 1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 7 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Accuracy: 2 percent, per ASTM E 77.
 - 4. Calibration: Degrees F.

2.4 THERMOMETER SUPPORTS

- A. Socket: Brass or stainless steel separable sockets for thermometer stems. Provide cap and chain where not used to mount permanent instrument or control sensor. Provide lagging extension when mounted on insulated pipe.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide pressure gauge on incoming side of backflow preventer assemblies. Provide one pressure gauge downstream from each backflow preventer in accordance with details and notes.
- B. Provide one pressure gauge on incoming side of pressure regulating stations. Provide one pressure gauge downstream from each pressure reducing valve in accordance with details and notes.
- C. Install pressure tappings on piping where specified or shown on details. Provide ball valve to isolate each tapping connection to system. Extend nipples to allow clearance from insulation.
- D. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical. Fill sockets with SAE 10W oil for conduction.

- E. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.2 SCHEDULES

A. Pressure Gauges, Location and Scale Range:

- 1. Pressure reducing valves, 0 to 160 psi.
- 2. Backflow preventers, 0 to 160 psi.

B. Stem Pipe Type Thermometers Scale Range:

- 1. Provide thermometers where shown on details and specified.
- 2. Domestic tempered, hot water supply and recirculation, 30 to 180 degrees F.

END OF SECTION 22 0519

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates
- B. Pipe Markers

1.2 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007 (ANSI/ASME A13.1).
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.3 SUBMITTALS

- A. Refer to Section 22 0510- General Plumbing Requirements, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for plumbing identification.
- C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
- B. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- C. Size: 1/2 inch high letters unless otherwise noted.

2.2 PIPE MARKERS

- A. Manufacturers: Brimar, Seton Name Plate Co Setmark, Kolbi Industries Style A thru E(5 inch and smaller) else Style F thru H, Marking Services.
- B. Pipe Markers for Indoor Use: Seton Setmark; media indicator with direction-of-flow arrows on calendared vinyl sheet; snap-around type for pipe sizes to 5-7/8 inches diameter, strap around type with nylon ties for pipe sizes 6 inches diameter and larger.

- C. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. Identify equipment such as pumps, water heaters, tanks, compressors and enclosed motor controllers with plastic nameplates.
- D. Identify small devices, such as in-line pumps, with tags.
- E. Identify control panels and major control components outside panels with plastic nameplates.
- F. Install Pipe Markers on all piping systems at the following Locations:
 - 1. Mechanical Equipment Rooms:
 - a. Within 18 inches of each valve.
 - b. Within 36 inches of each 90° elbow, tee, connection to equipment or vessel and point where pipe exits room.
 - c. At not over 20 feet intervals along all exposed piping.
 - 2. Above Suspended Ceilings:
 - a. Within 18 inches of each valve or valve assembly.
 - b. At tees, identify both main and branch within 36 inches of tee.
 - c. Within 36 inches of each 90° elbow.
 - d. At not over 15 feet intervals along all concealed piping.
 - 3. Piping Exposed in Rooms Other Than Mechanical Equipment Areas:
 - a. Omit identification on piping, 1 inch exterior diameter or smaller(insulated or uninsulated) or exposed at connections to equipment or plumbing fixtures.
 - b. With the above exception, identify at not less than one point each piping run visible in each room, with identification on not over 20 feet intervals.

END OF SECTION 22 0553

SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation
- B. Jackets and accessories

1.2 RELATED REQUIREMENTS

- A. Section 22 0510 - General Plumbing Requirements
- B. Section 22 0553- Identification For Plumbing Piping and Equipment
- C. Section 22 1005 - Plumbing Piping

1.3 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- C. ASTM C 411 - Test Method for Hot-Surface Performance of High Temperature Thermal Insulation.
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- E. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- G. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.
- H. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2012.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- J. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association 2007.

- K. UL 910 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 22 0510 - General Plumbing Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. All insulation, mastics, coatings, sealants, and adhesives shall be certified by the manufacturer to be Asbestos-free.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- C. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER (RIGID)

- A. Manufacturers:
 - 1. Knauf Insulation; Earthwool 1000° Pipe Insulation: www.knaufinsulation.us/en.
 - 2. Johns Manville Corporation; Micro-Lok HP Ultra: www.jm.com.
 - 3. Owens Corning Corp; SSLII with ASJ Max Fiberglas Pipe Insulation: www.owenscorning.com.
- B. Insulation: ASTM C 547; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C355 , 0.24 at 100 degrees F (0.035 at 38 degrees C).
 - 2. Maximum service temperature: 850 degrees F.
 - 3. Moisture sorption by weight: Less than 5%.
- C. Jacketing: ASTM C1136; Polymer or Polypropylene coated factory applied vapor barrier jacket with self-sealing lap and butt strips; moisture vapor transmission, when tested in accordance with ASTM E 96 Procedure A, of 0.01 perms max.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.3 GLASS FIBER, FLEXIBLE

- A. Manufacturers: Certainteed, Knauf, Owens-Corning, JohnsManville.
- B. Insulation: ASTM C 553; flexible, noncombustible blanket.
 - 1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C 518.
 - 2. Maximum Service Temperature: 250 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent by weight.
 - 4. Density: 3/4 lb./cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Tie Wire: Annealed stainless steel, 16 gage.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Armacell International; Model AP: www.armacell.com.
 - 2. Aerocel; Tube.
 - 3. K-Flex USA; Insul-Tube.
- B. Insulation: Preformed flexible closed-cell elastomeric rubber insulation complying with ASTM C534 Grade 1; use molded tubular material wherever possible.
 - 1. 'K' ('Ksi') value: ASTM C 177; 0.25 at 75 degrees F (0.04 at 24 degrees C).

2. Maximum moisture absorption: < 1.0 percent (pipe) by volume, when tested in accordance with ASTM C 209.
3. Water Vapor Permeability: 0.05 perm-inches, when tested in accordance with ASTM E 96.
4. Flame spread/smoke developed rating of 25/50 maximum when tested in accordance with ASTM E84 .
5. Minimum Service Temperature: -40 degrees F.
6. Maximum Service Temperature: 220 degrees F.
7. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 JACKETS

- A. ASJ (All Service Jacket): Polymer or Polypropylene coated factory applied vapor barrier jacket with self-sealing lap and butt strips; moisture vapor transmission, when tested in accordance with ASTM E 96 Procedure A, of 0.01 perms max. Jackets shall meet the requirements of ASTM C1136.
- B. Glass Fabric Vapor Barrier Finish;
 1. Cloth: Untreated 9 oz./sq. yd. weight.
 2. Blanket: 1.0 lb./cu ft density.
 3. Weave: 5x5.
 4. Lagging Adhesive: Fire resistant compatible with insulation.
 5. Finish: Vinyl emulsion type acrylic, compatible with insulation, grey color.

2.6 STAPLES, BANDS, AND WIRES

- A. Bands shall be galvanized steel, aluminum, brass, or nickel copper alloy, of 3/4 inch nominal width. The band thickness exclusive of coating shall be not less than 30 gauge for steel and nickel copper alloy.
- B. Wire shall be 18-gauge stainless steel.

2.7 ADHESIVES, COATINGS, SEALING COMPOUNDS AND PROTECTIVE FINISHES

- A. Lagging Adhesive and Coating for Glass Cloth Jackets and Other Facings - MIL-A-3316 B, Class 1.
- B. Lap Adhesive for Vapor Barrier Jacket - MIL-A-3316 B, Class 2.
- C. Bonding Adhesives - for securing insulation to metal surfaces - MIL-A-3316 B, Class 2 for temperature up to 200 degree F.
- D. Contact Type Adhesive - For installing flexible unicellular insulation - MIL-A-24179, Type II, Class 1.
- E. Bedding Compound and Joint Sealers - MIL-B-19564A.

- F. Coating Compound - Vapor Barrier Treatment - MIL-C-19565B, Type 1 or II.
- G. Protective Finish Outside of Buildings - Coating Compound MIL-C-19565 B, Type I.
- H. Manufacturers: Childers, Foster, Armstrong, Mon-Eco.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations. Exterior of insulation shall be uniform in appearance.
- D. Insulation jacket shall fit snug to insulation.
- E. Fixture Supply Piping Exposed and in Cabinets: Do not insulate.
- F. Domestic Cold Water Piping in Plumbing Chases and Concealed in Non-exterior Walls: Do not insulate.
- G. Floor Drain Primer: All horizontal piping and vertical piping up to 6" above the finished floor shall be insulated. Insulate same as Domestic Cold Water where located above slab on grade. Where located below grade, provide 1-inch thick flexible elastomeric cellular insulation.
- H. Valves and fittings:
 - 1. Insulate pipe and all valves and fittings including valve bonnets on domestic cold water, domestic hot water, horizontal storm drainage, and horizontal insulated waste piping. Leave only valve stems, open ends of wells and gauge cocks exposed.
- I. Insulation at Hangers: Hangers for condensate drain, horizontal storm drain, horizontal insulated waste piping, domestic water, and trapeze supports shall be outside of insulation with saddles as specified herein.
- J. Saddles: Provide galvanized steel saddles at each point where pipe insulation passes through a hanger or rests on a support. Saddles shall be 180 arc for horizontal piping, 360 arc for vertical piping. Length and gauge of saddle shall be as follows:
 - 1. 2 inch pipe size and smaller: 18 Gauge saddle, 8 inch long, minimum.
 - 2. 2-1/2 & 3 inch pipe size: 18 Gauge saddle, 12 inch long, minimum.

3. 4 inch pipe size:16 Gauge saddle,16 inch long, minimum.
- K. Insulated roof drain piping: Provide vapor barrier jackets, factory-applied or field-applied. Secure with either tape or self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Insulate fittings and joints. For exposed piping insulate fittings with molded insulation of like material and thickness as adjacent pipe and finish with fiberglass cloth in mastic.
- L. Flexible elastomeric cellular rubber insulation: Install without splitting and under compression during pipe fabrication. Seal Joints with adhesive. Paint exposed insulation with two coats of vinyl insulation paint after adhesive has dried for twelve hours, minimum. Allow two hours, minimum, between coats.
- M. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 22 0510.
- N. Fiber Glass, Flexible:
 1. Do not pull insulation tight around pipes.
 2. Lap transverse joints 2 inch, minimum and secure with staples 18 inches on center.
 3. Wrap insulation with Tie Wire 18 inches on center, maximum.

3.3 CLEANING

- A. Clean adjacent surfaces, valves, valve handles, etc. of jacketing materials.

3.4 SCHEDULES

- A. Plumbing Systems:
 1. Domestic Water:
 - a. Domestic Hot, Tempered, and Circulating Piping: Concealed Above Ceilings and in Walls: 1.5 inch thick rigid glass fiber with factory ASJ jacket.
 - b. Domestic Cold Piping: Concealed Above Ceilings and in Exterior Walls: 1 inch thick rigid glass fiber with factory ASJ jacket.
 - c. Exposed Piping Above 10ft Above Finished Floor Domestic Hot, Tempered, and Circulating Piping: 1.5 inch thick rigid glass fiber with factory ASJ jacket.
 - d. Exposed Piping Above 10ft Above Finished Floor Domestic Cold Piping: 1 inch thick rigid glass fiber with factory ASJ jacket.
 - e. Exposed Piping Below 10ft Above Finished Floor Domestic Hot, Tempered, and Circulating Piping: 1.5 inch thick rigid glass fiber with glass fabric vapor barrier jacket.
 - f. Exposed Piping Below 10ft Above Finished Floor Domestic Cold Piping:1 inch thick rigid glass fiber with glass fabric vapor barrier jacket.
 2. Roof Drain Bodies: Flexible glass fiber; 1-1/2 inch thick.
 3. Concealed Horizontal Roof Drainage Above Grade and Vertical Piping Above First Elbow: Flexible fiberglass blanket type, ½-inch minimum thick.
 4. Exposed Horizontal Roof Drainage Above Grade and Vertical Piping Above First Elbow: Rigid fiberglass with ASJ;1/2 inch thick.
 5. Roof Drain Overflow Piping: Insulate within 10 feet of the exterior connection.

6. Concealed Waste piping handling HVAC Condensate Above Grade: 1 inch thick phenolic foam with Saran vapor jacket. Insulate fittings with pipe insulation mitered to fit.
7. Exposed Waste piping handling HVAC Condensate Above Grade: 1 inch thick phenolic foam with Saran vapor jacket and PVC finish jacket. Insulate fittings with pipe insulation mitered to fit.

END OF SECTION 22 0719

SECTION 22 1005 - PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary sewer
 - 2. Force Main
 - 3. Domestic water
 - 4. Storm water
 - 5. Natural Gas
 - 6. Flanges, unions, and couplings.
 - 7. Pipe hangers and supports.
 - 8. Valves

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
- C. Section 22 0510 - General Plumbing Requirements.
- D. Section 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.
- E. Section 22 0719 - PLUMBING PIPING INSULATION.
- F. Section 22 1006 - Plumbing Specialties
- G. Section 22 4010- Plumbing Fixtures

1.3 REFERENCE STANDARDS

- A. NSF/ANSI 372 - American National Standard for procedures in evaluating product compliance with the 0.25% maximum weighted average lead content requirement.
- B. ANSI Z21.22 - American National Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems; 1999, and addenda A&B (R2004).
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.
- D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

- G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; 2012.
- H. ASME B31.1 - Power Piping; 2014.
- I. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.
- J. ASME B31.9 - Building Services Piping; 2014.
- K. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- M. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2015.
- N. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- O. ASTM A 888 - Hubless Cast Iron Pipe and Fittings.
- P. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- Q. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2015a.
- R. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2011.
- S. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- T. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- U. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes; 2012.
- V. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2013.
- W. ASTM C4 - Standard Specification for Clay Drain Tile and Perforated Clay Drain Tile; 2004 (Reapproved 2014).
- X. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2014.
- Y. ASTM C 1540-04- Standard Specification for Heavy Duty Shielded Couplings joining Hubless Cast Iron Soil Pipe and Fittings.
- Z. ASTM C 1563- Standard test method for Gaskets for use in Connection with Hub and Spigot Cast Iron Soil Pipe and Fittings for Sanitary Drain, Waste, Vent and Storm Piping Applications.
- AA. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.

- AB. ASTM F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80; 2013.
- AC. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80; 2013.
- AD. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2014.
- AE. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.
- AF. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.
- AG. AWWA C651 - Disinfecting Water Mains; 2005.
- AH. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; 2009.
- AI. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2011.
- AJ. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- AK. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; 2011.
- AL. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; 2011.
- AM. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; 2011.
- AN. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
- AO. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- AP. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
- AQ. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2019.
- AR. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015).
- AS. NSF 372 - Drinking Water System Components - Lead Content; 2011.

1.4 SUBMITTALS

- A. Refer to Section 22 0510 - General Plumbing Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

- C. Project Record Documents: Record actual locations of valves.

1.5 QUALITY ASSURANCE

- A. Products specified this section to be installed in a potable water system anticipated for human consumption shall be in compliance with the amended Safe Drinking Water Act S.3874, to reduce lead in drinking water. "Reduction of Lead in Drinking Water Act". 0.25% allowable lead content.
- B. Refer to Section 22 0510 - General Plumbing Requirements for installer requirements.
- C. All cast iron pipe and fittings shall be marked with the Collective Trademark of the Cast Iron Soil Pipe Institute.
- D. Perform Work in accordance with State of Georgia, standards.
- E. Valves: Manufacturer's name and pressure rating marked on valve body.
- F. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
- G. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.
- H. Perform Work in accordance with State of Georgia plumbing code.
- I. Conform to applicable code for installation of backflow prevention devices.
- J. Disinfection shall be in accordance with Environmental Protection Division, Georgia Department of Natural Resources "Rules for Safe Drinking Water".
- K. Domestic water piping system shall be sterilized, complying with Federal Specifications BB-C-120. Work shall be performed by licensed operator.
- L. Water Sample Certification: Water samples from the sterilized domestic water piping system shall be tested and approved by the local Health Department.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 SANITARY SEWER PIPING, BURIED AND WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A 74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 gaskets or lead and oakum.

2.3 SANITARY SEWER PIPING, ABOVE SLAB ON GRADE:

- A. Cast Iron Pipe: CISPI 301 or ASTM A888, hubless.
 - 1. Fittings: Cast iron.
 - 2. Joints: Shielded Couplings ASTM C 1277 Assembly: CISPI 310 and ASTM C 1540-04, with stainless steel shield, stainless steel clamp and tightening devices, and ASTM C 564 rubber sleeve.
 - a. Manufacturers - 1½" thru 3": Medium Duty: Mission Heavyweight, Husky HD 2000; Clamp-ALL-80, Tyler Wide Body, Ideal HD, Mifab XHUB.
 - b. Manufacturers - 4" thru 10": Heavy Duty: Husky SD 4000; Clamp-ALL-120, Mifab XHUB.

2.4 FORCE MAIN: (Elevator Sump Pump Piping)

- A. Steel Pipe (Above Ground): ASTM A 53, Schedule 40 galvanized steel.
 - 1. Malleable Iron Fittings: ASME B16.3, screwed type.
 - 2. Mechanical Grooved Couplings: Malleable iron, galvanized.

2.5 WATER PIPING, ABOVE SLAB ON GRADE:

- A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
 - 1. Fittings: ASME B16.18, ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B 32, alloy Sn95 solder.

2.6 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.

2.7 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301 or ASTM A888, hubless.
 - 1. Fittings: Cast iron.
 - 2. Joints: Shielded Couplings ASTM C 1277 Assembly: CISPI 310 and ASTM C 1540-04, with stainless steel shield, stainless steel clamp and tightening devices, and ASTM C 564 rubber sleeve.
 - a. Manufacturers - 1½" thru 3": Medium Duty: Mission Heavyweight, Husky HD 2000; Clamp-ALL-80, Tyler Wide Body, Ideal HD, Mifab XHUB.
 - b. Manufacturers - 4" thru 10": Heavy Duty: Husky SD 4000; Clamp-ALL-120, Mifab XHUB.

2.8 STORM WATER OVERFLOW PIPING

- A. Same as STORM WATER PIPING, ABOVE GRADE.

2.9 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A 53/A 53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A 234/A 234M, wrought steel welding type.
 - 2. Joints: NFPA 54, threaded or welded to ASME B31.1.
- B. Valve Connections: 2" and smaller - threaded; 2 1/2" and larger - flanged.

2.10 COMBUSTION AIR PIPING AND FLUE EXHAUST PIPING:

- A. CPVC Pipe: ASTM D 2846/D 2846M, ASTM F 441/F 441M, or ASTM F 442/F 442M.
 - 1. Fittings: CPVC; ASTM D 2846/D 2846M, ASTM F 437, ASTM F 438, or ASTM F 439.
 - 2. Joints: ASTM D 2846/D 2846M, solvent weld with ASTM F 493 solvent cement.

2.11 UNIONS, FLANGES AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches and Under:
 - 1. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Size Over 1 Inch:
 - 1. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier. Provide where connecting ferrous and non-ferrous piping.

2.12 PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Anvil, B-Line, Grinnell, Globe or Michigan. Figure numbers are for Michigan.
- B. Plumbing Piping - Drain, Waste, and Vent:
 - 1. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis. Figure 400.
 - 2. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 3. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 4. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping - Water:
 - 1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Carbon steel, adjustable swivel, loop. Figure 100.
 - 2. Hangers for Cold Pipe Sizes 2 Inches and Over: Copper electroplated carbon steel , adjustable, clevis. Figure 402.
 - 3. Multiple or Trapeze Hangers(Up to 2 inch: Green epoxy coated, cold formed, lipped steel channels, sized for pipe load and span, 1-5/8" x 1-5/8" x 12 gauge minimum, with pipe/tubing clamps, elastomer cushion, spring held, hardened steel nuts and hanger rods.
 - 4. Vertical Support: Steel riser clamp.
 - 5. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.13 BALL VALVES

- A. Up To and Including 2-1/2 Inches:
 - 1. Manufacturers:
 - a. Apollo; Model 77CLF2 Series
 - b. Crane; Model LF9202
 - c. Ferguson; Model X421
 - d. Hammond; Model UP8911
 - e. Milwaukee; Model UPBA485B
 - f. Red-White Valve Corp.; Model 5049AB
 - g. Stockham; Model LF-S-255-FB-P
 - h. Watts; Model LFFBVS-3C
 - i. American Valve; Model G100S
 - 2. MSS SP-110, NSF-61, 150 WSP, 600 WOG, Brass or Bronze two piece body, Full port, chrome plated brass ball, reinforced teflon seats and stuffing box ring, blow-out proof stem design, adjustable packing gland, zinc coated steel lever handle with vinyl hand grip , Solder ends .
- B. Up To and Including 2-1/2 Inches:
 - 1. Manufacturers:
 - a. Apollo; Model 77CLF1 Series
 - b. Crane; Model LF9201
 - c. Ferguson; Model X420
 - d. Hammond; Model UP8901

- e. Milwaukee; Model UPBA475B
 - f. Red-White Valve Corp.; Model 5044AB
 - g. Stockham; Model LF-T-255-FB-P
 - h. Watts; Model LFFBV3C
 - i. American Valve; Model G100
2. MSS SP-110, NSF-61, Class 150, 600 psi CWP, Brass or Bronze two piece body, Full port, chrome plated brass ball, reinforced teflon seats and stuffing box ring, blow-out proof stem design, adjustable packing gland, zinc coated steel lever handle with vinyl hand grip , threaded ends .

2.14 CAST IRON BALL VALVES

- A. 3 Inches and Larger:
 1. Manufacturers:
 - a. American Valve; Model 3700.
 - b. Watts; Model G4000M1, epoxy coated.
 - c. Apollo; Model 6PLF.
 2. MSS SP-72, NSF-61, NSF-372, 125 WSP, 200 WOG, Cast Iron body, Full port, stainless steel or teflon infused cast iron ball, Buna-N or PTFE seats, blow-out proof stem design, adjustable packing gland, cast iron or steel lever handle with vinyl hand grip , Flanged ends .

2.15 GAS VALVES

- A. 2-Inches and smaller
 1. Manufacturers:
 - a. Apollo; Model 64:
 - b. Crane; Model 9200 Series:
 - c. Hammond; Model 8901
 - d. Milwaukee Valve; Model BA475B
 - e. Stockham; Model S206-UFBR
 - f. Watts; Model FVB-3
- B. MSS SP-110, 600 WOG, B16.44 5 PSIG, Z21.15 1/2 PSIG, Brass/bronze two piece body, full port, teflon packing, chrome plated brass ball, threaded ends.

2.16 PLUG VALVES

- A. Manufacturers: 2 1/2" and larger, flanged
 1. Resun; Model R-1431. www.rmenergy.com
 2. Nordstrom Valves; www.flowserve.com
- B. Construction 2-1/2 Inches and Larger: MSS SP-78, 200 psi WOG, ASTM A 126 Class B cast iron body and plug, stainless steel spring, glass filled TFE gasket, flanged ends.

2.17 GAS PRESSURE REDUCING VALVE

- A. Cast iron body with brass seat; 2 PSI maximum inlet pressure and 10" W.C. outlet pressure. Refer to schedule on drawings. Sensus 243 Series, Itron B34 Series, and American meter 1800 Series.

2.18 FLOW INDICATOR-BALANCER CONTROLS

- A. Manufacturers:
 - 1. AAF:
 - 2. Caleffi
 - 3. ITT Bell & Gossett:
 - 4. Armstrong.
 - 5. Taco.
 - 6. Tour & Anderson; Model IMI-TA
 - 7. Watts.
- B. Balancer: Calibrated bronze screwed balance valve with indicating pointer, memory stop, and with pressure taps for connecting differential pressure meter. Pressure taps shall be equipped with caps and integral check valves. Each valve shall have preformed, removable insulation cover. Locate to provide unrestricted flow up and down-stream in accordance with manufacturer's recommendations. Valves shall be ANSI/NSF-61 Annex G Compliant
- C. Meter: Portable differential pressure gauge with flexible tubing, shut-off valves and case. Deliver gauge to Operating Personnel upon completion of testing and balancing. B&G RO-2, AAF PG-1, Taco Circuit Setter meter, Flow Set 300.5, TA Scope, Caleffi.
- D. Balance Valve shall be ANSI/NSF-61 Annex G Compliant.

2.19 SWING CHECK VALVES

- A. 2-Inches and smaller
 - 1. Manufacturers:
 - a. Apollo; Model 161SLF
 - b. Crane; Model LF1340
 - c. Hammond Valve; Model UP912
 - d. Milwaukee Valve; Model UP1509
 - e. Nibco, Inc: Model S-413-Y-LF
 - f. Red-White Valve Corp.; Model 237AB
 - g. Stockham; Model LFB-309Y
 - 2. MSS SP-80, NSF-61, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends
- B. 2-Inches and smaller
 - 1. Manufacturers:
 - a. Apollo; Model 161TLF
 - b. Crane: Model LF37
 - c. Hammond Valve; Model UP904

- d. Milwaukee Valve; Model UP509
- e. Nibco, Inc.: Model T-413-Y-LF
- f. Red-White Valve Corp.; Model 236AB
- g. Stockham; Model LFB-319Y
2. MSS SP-80, NSF-61, Class 125, bronze body and cap, bronze swing disc with rubber seat, threaded ends

2.20 Water Pressure Reducing Valves:

A. Manufacturers:

1. Apollo; Model 36LF-H
2. Watts Regulator Company; Model LF223-S-B
3. Wilkins; Model 500XLYSBR

B. Up to 2 Inches:

1. MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends. Made in the USA with corrosion resistant materials. Valve shall be made in the USA with corrosion resistant components and materials.

2.21 RELIEF VALVES

A. Pressure Relief:

1. Manufacturers:
 - a. Cla-Val Company: www.cla-val.com.
 - b. Henry Technologies: www.henrytech.com.
 - c. Watts Regulator Company: www.wattsregulator.com.
 - d. Conbraco/Apollo; 10-600.
2. AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated. Hot water, ASME Section IV Safety Relief.

B. Temperature and Pressure Relief:

1. ASME approved in accordance with Unfired Pressure Vessel Code, Section 8, UG-136, Safety and Relief Valves. Route discharge to floor.
2. Manufacturers:
 - a. Cash Acme;
 - b. Cla-Val Company: www.cla-val.com.
 - c. Henry Technologies: www.henrytech.com.
 - d. Watts Regulator Company: www.wattsregulator.com.
 - e. Conbraco/Apollo; 18-500.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- A. Each type of pipe installed shall be by the same manufacturer throughout the building.
- B. Each type of fittings installed shall be by the same manufacturer throughout the building.
- C. Install in accordance with manufacturer's instructions.
- D. Equipment and pipe support upper attachments shall be 3" x 3" x 1/4" steel angles, minimum, spanning structural members unless noted otherwise. Provide inserts and bolts for supporting pipes and equipment from structural members. Attachments shall be to top cord of bar joists. Attach to beams with beam clamps. DO NOT support from roof deck.
- E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- H. Maintain 4 inch clearance between pipe and fittings after insulation.
- I. Group piping whenever practical at common elevations.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- L. Provide access where valves and fittings are not exposed.
- M. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
- N. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- O. Flush all debris and pipe compound from domestic water system.
- P. Install bell and spigot pipe with bell end upstream.
- Q. Install valves in a readily accessible location.
- R. Install valves with stems upright or horizontal, not inverted.

- S. Install water piping to ASME B31.9.
- T. Sleeve pipes passing through partitions, walls and floors. Where pipes pass thru exterior walls, seal opening between sleeve and pipe.
- U. Pipe discharge of each pressure relief valve individually to floor, unless otherwise noted.
- V. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Use double nuts and lock washers on threaded rod supports.
 - 8. Provide copper plated hangers and supports for copper piping where hanger is in contact with tubing.
 - 9. Prime coat concealed steel hangers and supports not provided with a corrosion resistant finish. Refer to Section 09 9000.
 - 10. Support drainage piping within 12 inches of every joint.
 - 11. Provide rigid sway bracing upstream of all changes in direction greater than 45 degrees for horizontal storm and sanitary drainage piping 4" and larger.
- W. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a water-tight seal.
 - 6. Install in accordance with manufacturer's recommendations.

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers as shown on drawings.
- C. Install balance valves for throttling, bypass, or manual flow control services.

3.5 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/8 inch per foot slope.
- B. Interior Water Piping: Maintain top of piping level with concentric reducers. Arrange to drain at low points.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.7 SCHEDULES

- A. Hanger spacing indicated as maximum span based on pipe material and size. Conform to structural spacing and load capacity of structural support points and provide closer spacing as required.
- B. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inches to 3 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - 2. Metal Piping:
 - a. Copper Pipe size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum hanger spacing: 5 ft.

- 2) Hanger rod diameter: 3/8 inches.
- b. Copper Pipe size: 1-1/2 inches to 4 inches:
 - 1) Maximum hanger spacing: 8 ft.
 - 2) Hanger rod diameter: 3/8 inch.
- c. Waste/Vent Pipe size: 2 inches to 3 inches:
 - 1) Maximum hanger spacing: 8 ft.
 - 2) Hanger rod diameter: 1/2 inch.
- d. Waste/Vent Pipe size: 4 inches to 6 inches:
 - 1) Maximum hanger spacing: 8 ft.
 - 2) Hanger rod diameter: 5/8 inch.
- e. Storm Pipe size: 3 inches to 6 inches:
 - 1) Maximum hanger spacing: 8 ft.
 - 2) Hanger rod diameter: 5/8 inch.
- f. Storm Pipe size: 8 inches to 12 inches:
 - 1) Maximum hanger spacing: 10 ft.
 - 2) Hanger rod diameter: 7/8 inch.

END OF SECTION 22 1005

SECTION 22 1006 - PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof Drains
- B. Roof Overflow Drains
- C. Downspout Nozzles
- D. Floor Drains
- E. Cleanouts
- F. Hose Bibbs
- G. Hydrants
- H. Backflow Preventers
- I. Water hammer arrestors
- J. Digital Mixing Valve
- K. Trap Primers
- L. Trap Sealer Assembly
- M. Flashing

1.2 RELATED REQUIREMENTS

- A. Section 22 0510 - General Plumbing Requirements
- B. Section 22 0519 - Meters and Gages for Plumbing Piping
- C. Section 22 1005 - Plumbing Piping

1.3 REFERENCE STANDARDS

- A. NSF/ANSI 372 - American National Standard for procedures in evaluating product compliance with the 0.25% maximum weighted average lead content requirement.
- B. ASME A112.6.3 - Floor and Trench Drains; 2001 (R2007).
- C. ASSE 1011 - Hose Connection Vacuum Breakers; 2004.

- D. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; 2009.
- E. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011.
- F. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015).
- G. NSF 372 - Drinking Water System Components - Lead Content; 2011.
- H. PDI-WH 201 - Water Hammer Arresters; 2010.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Refer to Section 22 0510 - General Plumbing Requirements, for submittal requirements.
- C. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- D. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- F. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, piping and valves.

1.5 QUALITY ASSURANCE

- A. Products specified this section to be installed in a potable water system anticipated for human consumption shall be in compliance with the amended Safe Drinking Water Act S.3874, to reduce lead in drinking water. "Reduction of Lead in Drinking Water Act". 0.25% allowable lead content.
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

1.7 EXTRA MATERIALS

- A. Two loose keys for outside hose bibs.
- B. Two hose end vacuum breakers for hose bibs.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.2 ROOF DRAINS

- A. Roof/Overflow Drain: RD/OD
 - 1. Assembly: ASME A112.6.4. Combined roof and overflow drain attached to dual drain deck plate.
 - 2. Manufacturers:
 - a. Josam; Model 22500-26-VP-Z
 - b. Mifab; Model R1270-M-80-P-C-U
 - c. J. R. Smith; Model 1850Y-E-C2-U-AD
 - d. Zurn; Model Z-163-NH-ZA-VP-EA
 - 3. Body: Lacquered cast iron with sump.
 - 4. Strainer: Removable cast aluminum dome with vandal proof screws.
 - 5. Accessories: Coordinate with roofing type, refer to Architectural Specification Sections :
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Vandal Proof Dome.
 - c. No Hub pipe connection.
 - d. Controlled flow weir.
 - e. Leveling frame.
 - f. Adjustable extension sleeve for roof insulation.

2.3 DOWNSPOUT NOZZLES:

- A. Downspout Nozzle:
 - 1. Manufacturers:
 - a. Josam; Model 25010
 - b. Mifab; Model R1940
 - c. J. R. Smith; Model 1770
 - d. Wade; Model W-3940
 - e. Watts; Model RD-940
 - f. Zurn; Model Z-199
 - 2. Bronze round with straight bottom section.

2.4 FLOOR DRAINS

- A. Floor Drain (FD-A): In Finished Spaces
 - 1. Manufacturers:
 - a. Josam; Model 30000-S-Y
 - b. Mifab; Model F1100C-S(P)-1

- c. J. R. Smith; Model 2005L(B)
- d. Wade; Model 1100G(TY)
- e. Watts; Model FD-100-M-P
- f. Zurn; Model ZN415S(NL)
2. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, square, adjustable nickel-bronze strainer.

B. Floor Drain (FD-B): In Mechanical Spaces

1. Manufacturers:
 - a. Josam; Model 32300V-50-69-1
 - b. Mifab; Model F1340-Y-14
 - c. J. R. Smith; Model 2131L-P050-B-NB
 - d. Wade; Model 1210(TY)-1-27
 - e. Watts; Model FD-340-Y-P
2. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and adjustable round nickel bronze strainer with removable perforated sediment bucket and trap primer connection.

2.5 CLEANOUTS

A. Heavy Duty Cleanouts at Exterior Surfaced Areas (XHCO):

1. Manufacturers:
 - a. Josam; Model 58680
 - b. Mifab; Model C1300-MF/1230
 - c. J.R. Smith; Model 4262L
 - d. Watts; Model CO-300-MF
 - e. Zurn; Model Z1474-SG
 - f. Wade
2. Round cast iron cleanout and double flanged housing with heavy duty secured scoriated cast iron cover with lifting device. Speedi-set outlet with gasket seal and bronze plug.

B. General Cleanouts at Exterior Unsurfaced Areas (GCO):

1. Manufacturers:
 - a. Josam; Model 58190-22
 - b. Mifab; Model C-1230
 - c. J.R. Smith; Model 4283S
 - d. Watts; Model CO-200
 - e. Zurn; Model Z1449
 - f. Wade; Model 8550-75
2. Line type cast iron cleanout with spigot outlet.

C. General Cleanouts at Exterior Surfaced Areas (GCO):

1. Manufacturers:
 - a. Josam; Model 55000-22
 - b. Mifab; Model C1100-XR
 - c. J.R. Smith; Model 4232L
 - d. Watts; Model CO-200-XR-4
 - e. Zurn; Model Z1400-NL-BP

- f. Wade; Model 6000-12-75
- 2. Round cast iron cleanout with adjustable scoriated top, and bronze plug.

D. Cleanouts at Interior Finished Floor Areas (FCO):

- 1. Manufacturers:
 - a. Josam; Model 55000
 - b. Mifab; Model C-1100P-R
 - c. J.R. Smith; Model 4032L
 - d. Watts; Model
 - e. Zurn; Model ZN1400-NL-BP
 - f. Wade; Model 6000-1-75
- 2. Lacquered cast iron body with anchor flange, flashing clamp and round adjustable secured Nickel Bronze top assembly with bronze plug and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

E. Cleanouts at Interior Finished Wall Areas (WCO):

- 1. Manufacturers:
 - a. Josam; Model 58600
 - b. Mifab; Model C-1430-RD
 - c. J.R. Smith; Model 4472
 - d. Watts; Model CO-590-RD
 - e. Zurn; Model Z-1468
 - f. Wade; Model 8590/8304
- 2. Line type with cast bronze taper threaded plug with round stainless steel access cover secured with machine screw.

2.6 HOSE BIBBS

A. Interior Hose Bibbs:

- 1. Manufacturers:
 - a. Nibco; Model 763VB-LS
 - b. Woodford; Model 24P
 - c. T&S Brass; Model B-0736
 - d. Prier; Model C255CP
- 2. Brass body with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome plated where exposed with lockshield and removable key, integral vacuum breaker in conformance with ASSE 1011. Rough brass finish in mechanical spaces.

2.7 HYDRANTS

A. Wall Hydrants: Fully recessed in flush mounting box. Box and door shall be cast bronze.

- 1. Manufacturers:
 - a. J.R. Smith; Model 5509QT-15
 - b. Josam; Model 71000
 - c. Prier; Model C634N-BX1
 - d. Wade; Model W-8625

- e. Watts; Model HY-42B
- f. Woodford; Model B65
- g. Zurn; Model Z-1320
2. ASSE 1019; freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.8 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers:
 1. Manufacturers: (3/4-inch - 2-inch)
 - a. Apollo; Model RPLF4A-21-T2-F
 - b. Febco; Model LF825Y
 - c. Watts; Model LF009M2-QT-S
 - d. Wilkins; Model 375XL-S
 2. ASSE 1013; bronze body with stainless steel internal parts and two independently operating, spring loaded check valves; intermediate relief valve non threaded vent outlet; assembled with two quarter turn full port ball valves, bronze strainer, and four test cocks, vent/relief shall be discharged via fixed air gap and funnel. Pipe discharge, full size, to floor drain.

2.9 WATER HAMMER ARRESTORS

- A. Manufacturers: Unit Size: 'A'
 1. Jay R. Smith; Model 5205-SC Series
 2. Watts; Model LF15M2 Series
 3. Mifab; Model MWH-A
 4. Sioux Chief; Model 650 Series
 5. Josam; Model 75001-S
 6. Wade; Model 5P
 7. Wilkins; Model 1250XL-A
 8. Zurn; Model WH2950-A-XL
- B. Manufacturers: Unit Size: 'B'
 1. Jay R. Smith; Model 5210-SC Series
 2. Watts; Model LF15M2 Series
 3. Mifab; Model MWH-B
 4. Sioux Chief; Model 650 Series
 5. Josam; Model 75002-S
 6. Wade; Model 10P
 7. Wilkins; Model 1250XL-B
 8. Zurn; Model WH2950-B-XL
- C. Manufacturers: Unit Size: 'C'
 1. Jay R. Smith; Model 5220-SC Series
 2. Watts; Model LF15M2 Series
 3. Sioux Chief; Model 650 Series
 4. Josam; Model 75003-S
 5. Wade; Model 20P

6. Wilkins; Model 1250XL-C
7. Zurn; Model WH2950-C-XL

D. Water Hammer Arrestors:

1. ANSI A112.26.1M Copper construction, piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range 33 to 180 degrees F and maximum 150 psi working pressure. Locate valve(s) above ceiling height of adjacent space.

2.10 DIGITAL MIXING VALVES

A. Digital Water Mixing Valves:

1. Manufacturers:
 - a. Lawler.
 - b. Leonard.
 - c. Power; Model Intellistation LFIS075VL.
 - d. Symmons.
2. System shall control water temperature to +/- 2°F in accordance with ASSE 1017 and resist "temperature creep" during periods of low/zero demand. Controller shall be password protected and feature a user-adjustable outlet temperature range of 60 - 180°F with high and low temperature alerts, and an approach temperature of 2°F.
3. System shall digitally control and monitor mixed outlet temperature. Controller shall integrate with building automation systems (separate module not required) through BACnet and Modbus protocols and feature local and remote temperature alarms. System will feature a user-set, high-temperature sanitization mode for thermal disinfection of bacteria and a programmable temperature set back feature to improve energy efficiency. System will also feature high speed actuator with override feature. In the event of a power failure, system will open full cold supply. In case of a loss of cold water, the system will close hot water supply.
4. System shall be listed/approved to ASSE 1017, cUPC, NSF, CSA 24/UL873 and BTL (BACnet Testing Laboratories)
5. Capacity: 16 gpm at 5 psi differential.

2.11 TRAP PRIMERS

A. Single Primer:

1. Cast brass unit with built-in air gap/backflow preventer, 1/2 inch inlet and 1/2 inch outlets.
2. Manufacturers: Precision Plumbing Products (PPP) PR-500, Mifab M-500-NPB w/MI-GAP, Watts LFTP300T-DR.
3. See detail on plans.

B. Multiple Trap Primer:

1. Trap Primer Valve: Brass trap primer valve with O-ring seals and integral vacuum breaker. Adjustable from 2 oz. to 5 oz. flow rate.
2. Distribution Unit: Brass body with clear plastic inspection cover top and 4 distribution opening(s) in the bottom.

3. Manufacturers: Precision Plumbing Products, Inc. (PPP) PR-500 w/DU-2/3/4, Mifab M-500-NPB w/MI-GAP and MI-DU, and Watts LFTP300T-DR with LFTP300-DU-DR. Pipe per manufacturer's instructions.
4. See detail on plans.

2.12 TRAP SEALER ASSEMBLY

- A. Manufacturers:
 1. Sure Seal
 2. Proset
 3. J.R. Smith
- B. Inline elastomeric material waterless trap protection. Size to match drain.
- C. Ten year warranty

2.13 FLASHING

- A. Cast Iron Vents Thru Roof Unless Otherwise Noted: Flashing provided by roof manufacturer.
- B. Plastic Pipe Vents Thru Roof: Neoprene flashing collar.
- C. Roof and Overflow Drains: Flashing provided by roof manufacturer.
- D. Workmanship: Flashing materials shall be free of holes and splits, and all joints and seams shall be sealed watertight with solder.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install plumbing specialties in a readily accessible location.
- C. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- D. Encase exterior cleanouts in 6-inch concrete pad flush with grade. See detail.
- E. Install 2-way cleanouts at all sanitary sewer and storm drain pipes exiting the building. Refer to detail on drawings.
- F. Install floor cleanouts at elevation to accommodate finished floor.
- G. Floor drains shall be set at 1/8-inch below finish floor elevation. Refer to Architectural for sloping of floor.

- H. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, fire sprinkler systems, and irrigation systems.
- I. Pipe relief from backflow preventer to nearest drain.
- J. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to all fixtures and toilet batteries. Size and install in accordance with the (Plumbing and Drainage Institute Standard) PDI WH-201.

END OF SECTION 22 1006

SECTION 22 3000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water Heaters
- B. In-Line Circulators.
- C. Submersible Sump Pumps

1.2 RELATED REQUIREMENTS

- A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment
- B. Section 22 0519 - Meters and Gages For Plumbing Piping.

1.3 REFERENCE STANDARDS

- A. ANSI Z21.10.1 - Gas Water Heaters - Volume I - Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less; 2011.
- B. ANSI Z21.10.3 - Gas-Fired Water Heaters - Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous; 2014.
- C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.
- D. ICC (IPC) - International Plumbing Code; 2012.

1.4 REFERENCE STANDARDS

- A. NSF/ANSI 372 - American National Standard for procedures in evaluating product compliance with the 0.25% maximum weighted average lead content requirement.
- B. ANSI Z21.10.3 - Gas-Fired Water Heaters - Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous; 2014.
- C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; 2015.
- D. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2002.

1.5 SUBMITTALS

- A. Refer to Section 22 0510 - General Plumbing Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Certifications:
 - 1. Water Heaters: NSF approved.
 - 2. Gas Water Heaters: Certified by CSA International to ANSI Z21.10.1, as applicable, in addition to requirements specified elsewhere.
 - 3. Water Tanks: ASME labeled to ASME BPVC-VIII-1.
- C. Products specified this section to be installed in a potable water system anticipated for human consumption shall be in compliance with the amended Safe Drinking Water Act S.3874, to reduce lead in drinking water. "Reduction of Lead in Drinking Water Act". 0.25% allowable lead content.
- D. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- E. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- F. Standards: Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
 - 1. American Gas Association (AGA).
 - 2. National Sanitation Foundation (NSF).
 - 3. American Society of Mechanical Engineers (ASME).
 - 4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - 5. National Electrical Manufacturers' Association (NEMA).
 - 6. Underwriters Laboratories (UL).

- G. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.7 WARRANTY

- A. Provide warranties from date of Final Completion.
- B. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- C. Provide three year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.1 COMMERCIAL ELECTRIC WATER HEATERS

A. STORAGE TYPE WATER HEATER

- 1. Manufacturers:
 - a. A.O. Smith
 - b. Bradford White
 - c. Lochinvar
- 2. Type: Automatic, electric, vertical storage, Tall
- 3. Performance: (WH-2) Building 100
 - a. Storage capacity: 80 gal.
 - b. Heating element size: 4.5 kW
 - c. Number of heating elements: 2
 - d. Minimum recovery rate: 18 gph with 100 degrees F temperature rise.
 - e. Maximum working pressure: 150 psig.
- 4. Electrical Characteristics:
 - a. See Electrical. Three Phase Non-Simultaneous
- 5. Tank: Glass lined welded steel, thermally insulated with 2 inch foam insulation; encased in corrosion-resistant steel jacket; baked-on enamel finish.
- 6. Controls: Automatic water thermostat with externally adjustable temperature range from 110 to 170 degrees F for single element, medium watt density zinc plated copper elements. Factory installed manual reset high temperature cutoff and factory installed junction box where required.
- 7. Accessories: Provide:
 - a. Top Water Connections: Brass.
 - b. Dip tube: Brass.
 - c. Drain Valve.
 - d. Anode: Magnesium
 - e. ASME Rated Temperature and Pressure Relief Valve
 - f. See detail on drawing.

2.2 COMMERCIAL GAS WATER HEATERS

A. COMMERCIAL GAS FIRED CONDENSING TYPE WATER HEATER (WH-1) Building B

- 1. Manufacturer: PVI Model Conquest.

2. Acceptable manufacturers offering equivalent products.
 - a. A. O. Smith
 - b. Lochinvar.
 - c. Bradford White.
3. Type: Automatic, down-fired, pre-mix burner, vertical storage.
 - a. Unit shall be UL listed for venting with CPVC pipe.
 - b. The unit shall meet or exceed ASHRAE 90.1b-(2010) for recovery efficiency and stand-by heat loss
4. Performance:
 - a. Storage: 100 gallons.
 - b. Input: 199,000 Btuh at sea level.
 - c. Minimum recovery rate: 235 gph with 100 degrees F temperature rise.
 - d. Rated at 95% efficiency
5. Tank: Seamless Glass lined welded steel ASME labelled, or Aquaplex tank and Heating Surfaces. Meet or exceed thermal efficiency and standby loss requirements of the U.S. Department of Energy.
6. Accessories: Brass water connections and dip tube, drain valve, and ASME rated temperature and pressure relief valve.
7. Burner: The burner shall be a high efficiency down-fired pre-mix burner, U.L. Listed, FM and I.R.I specifications and meet ASHRAE 90 standards.
8. Controls: Automatic water thermostat with temperature range adjustable from 110 to 180 degrees F, automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.
9. Installation: The heater shall require hook-ups for electrical, gas, venting and plumbing only. The water heater assembly shall be located/positioned to allow for accessibility and maintenance of parts and components.

2.3 VACUUM RELIEF VALVE

- A. All bronze construction with silicone disc, integral body seat and brass working parts. Maximum water pressure 200 psi; maximum steam pressure 15 psi; maximum temperature 250 degrees Fahrenheit.
- B. Manufacturers: Watts N36, Cash Acme VR-801, or Wilkins VR10.

2.4 THERMAL EXPANSION TANKS

- A. Manufacturers:
 1. Amtrol Inc
 2. ITT Bell & Gossett
 3. Taco, Inc
 4. Zilmet;
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with heavy duty butyl diaphragm sealed into tank, and steel legs or saddles.

- C. Accessories: Pressure gage and air-charging fitting with purge valve, tank drain; precharge to 55 psig.
- D. Size: 12 inches diameter, 14 inches overall length, 6.4 gal capacity.

2.5 PUMPS

A. IN-LINE CIRCULATOR PUMP

- 1. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
- 2. Impeller: Bronze.
- 3. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- 4. Seal: Carbon rotating against a stationary ceramic seat.
- 5. Drive: Flexible coupling.
- 6. Performance:
 - a. Flow: 5 gpm, at 20 feet head.
 - b. Electrical Characteristics:
 - 1) 1/6 hp.
 - 2) 120 volts, single phase, 60 Hz, 15 minimum circuit ampacity.

B. SUBMERSIBLE ELEVATOR SUMP PUMP WITH OIL ALARM SYSTEM(2 Required)

- 1. Manufacturers:
 - a. Bell & Gossett
 - b. Goulds Pumps
 - c. Zoeller Pump Company: Model N188 with 10-2149 Control Panel
 - d. Myers Pumps; www.myers.com.
 - e. Weil Pump
 - f. Liberty Pumps
- 2. Type: Completely submersible, vertical, centrifugal, semi-open, non-clog.
- 3. Casing: Cast iron pump body and oil filled motor chamber.
- 4. Shaft: stainless steel.
- 5. Impeller: Bronze; open non-clog.
- 6. Bearings: Ball bearings.
- 7. Accessories: Oil Smart Pump Switch and Oil Smart Simplex Alarm Panel. 4x NEMA Enclosure with audible, light alarms, and dry contacts. Preset on and off points to differentiate oil detection and high water alarms for maintenance personnel. 20amp internal relay, and 304 Stainless Steel probes with UL508 approved switch. Dry contacts to allow for remote mounting control panel in mechanical room. Separate dry contacts in panel to provide an alarm signal to Building Automation System(BAS) indicating oil presence in elevator pit.
- 8. Performance:
 - a. Flow: 50 GPM, at 25 feet lift.
 - b. Motor: 3/4HP, 120 volt, single phase, 60 Hz.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Provide dielectric unions between the distribution piping and the cold and hot water connection piping provided with the water heater.
- C. Domestic Water Heaters:
 - 1. Install water heater on concrete housekeeping base, sized minimum 4 inches larger than heater base. Refer to Section 22 0510.
 - 2. Pipe relief valves to floor.
 - 3. Pipe drains to nearest floor drain.
 - 4. Provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
 - 5. Install circulator and blenders as detailed on Drawings.
 - 6. Provide for connection to electrical service.
- D. Pumps:
 - 1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
 - 2. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
 - 3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

3.2 STARTING EQUIPMENT.

- A. Demonstrate water heater operation and verify specified performance.
- B. Sump Pump:
 - 1. Maintain basin is clean and free of debris.
 - 2. Ensure level floats operate free and clear.
 - 3. Adjust level controls.
 - 4. Fill pit with water and mark On-Off levels on pit.
- C. Provide start-up certificate for water heater.

END OF SECTION 22 3000

SECTION 22 4010 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water closets (WC)
- B. Urinals (UR)
- C. Wall Hung Lavatories (LV)
- D. Sinks (SK)
- E. Mop Basins (MB)
- F. Ice Maker Supply Box (IB)
- G. Electric Water Coolers (EWC)
- H. Plumbing Fixtures' Fittings, Accessories, and Supplies

1.2 RELATED SECTIONS

- A. Section 12 3653 - Laboratory Equipment.
- B. Section 22 0510 - General Plumbing Requirements
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 1006 - Plumbing Specialties.
- E. Section 26 2717 - Equipment Wiring.

1.3 REFERENCES

- A. NSF/ANSI 372 - American National Standard for procedures in evaluating product compliance with the 0.25% maximum weighted average lead content requirement.
- B. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute; 1994.
- C. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997.
- D. ASME A112.18.1 - Plumbing Fixture Fittings; The American Society of Mechanical Engineers; 2000.

- E. ASME A112.19.2M - Vitreous China Plumbing Fixtures; The American Society of Mechanical Engineers; 1998.
- F. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 1999.

1.4 SUBMITTALS

- A. Refer to Section 22 0510 - General Plumbing Requirements for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Instructions: Indicate installation methods and procedures.
- D. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Products specified this section to be installed in a potable water system anticipated for human consumption shall be in compliance with the amended Safe Drinking Water Act S.3874, to reduce lead in drinking water. "Reduction of Lead in Drinking Water Act". 0.25% allowable lead content.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

- A. FIXTURE 'WC1'; WATER CLOSET (WH, FV(1.28 gpf), STD)
 - 1. Bowl:
 - a. Manufacturers:
 - 1) American Standard Inc; Model 2257.101
 - 2) Kohler Company; Model K-4325
 - 3) Toto; Model CT708U(G)
 - 4) Sloan; Model ST-2459
 - 5) Zurn; Model Z5615-BWL

- b. ASME 112.19.2M; 1.28gpf, wall hung vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud, china bolt caps; standard accessible.
 - 2. Fixture Accessories:
 - a. Seat: Type 1St; See SEATS.
 - b. Water Closet Carrier: See CARRIERS.
 - c. Flush Valve (1.28gpf): Type 2FV; See FLUSH VALVES.
- B. FIXTURE 'WC2'; WATER CLOSET (WH, FV (1.28 gpf), ADA)
 - 1. Bowl:
 - a. Manufacturers:
 - 1) American Standard Inc; Model 2257.101
 - 2) Kohler Company; Model K-4325
 - 3) Toto; Model CT708U(G)
 - 4) Sloan; Model ST-2459
 - 5) Zurn; Model Z5615-BWL
 - b. ASME A112.19.2M; 1.28 gpf, wall hung vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud, china bolt caps; disabled access.
 - 2. Fixture Accessories:
 - a. Seat: Type 1St; See SEATS.
 - b. Water Closet Carrier: See CARRIERS.
 - c. Flush Valve (1.28gpf): Type 2FV; See FLUSH VALVES.
- C. FIXTURE 'WC3'; WATER CLOSET (FM, FV (1.28 gpf), STD)
 - 1. Bowl:
 - a. Manufacturers:
 - 1) American Standard Inc: Model 2234.001
 - 2) Kohler Company: Model K-96053
 - 3) Toto: Model CT705UN
 - 4) Sloan: Model ST-2009
 - 5) Zurn: Model Z5655-BWL1
 - b. ASME A112.19.2M; 1.28 gpf, floor mounted vitreous china closet bowl with elongated rim, 1-1/2 inch top spud, china bolt caps; standard accessible.
 - 2. Fixture Accessories:
 - a. Seat: Type 1St; See SEATS.
 - b. Flush Valve (1.28gpf): Type 2FV; See FLUSH VALVES.
- D. FIXTURE 'WC4'; WATER CLOSET (FM, FV(1.28 gpf), ADA)
 - 1. Bowl:
 - a. Manufacturers:
 - 1) American Standard Inc: Model 3043.001
 - 2) Kohler Company: Model K-96057
 - 3) Toto: Model CT705ULN
 - 4) Sloan: Model ST-2029
 - 5) Zurn: Model Z5665-BWL1
 - b. ASME A112.19.2M; 1.28 gpf, floor mounted vitreous china closet bowl with elongated rim, 1-1/2 inch top spud, china bolt caps; disabled accessible.
 - 2. Fixture Accessories:
 - a. Seat: Type 1St; See SEATS.
 - b. Flush Valve (1.28gpf): Type 2FV; See FLUSH VALVES.

2.2 URINALS

A. FIXTURE 'UR1'; URINAL (WH,FV (0.125 gpf), STD)

1. Urinal:
 - a. Manufacturers:
 - 1) American Standard Inc; Model 6590.001
 - 2) Sloan; Model SU-1009
 - 3) Zurn; Model Z5755
 - 4) Toto; Model UT445U
 - 5) Kohler Company; Model K-4904-ET
 - b. ASME A112.19.2M; 0.125 gpf, vitreous china, wall hung wash-out urinal fixture with integral trap, 3/4" top spud, standard accessible.
2. Flush Valve (0.125gpf): Type 4FV
3. Urinal Carriers: See CARRIERS.

B. FIXTURE 'UR2'; URINAL (WH,FV (0.125 gpf), ADA)

1. Urinal:
 - a. Manufacturers:
 - 1) American Standard Inc; Model 6590.001
 - 2) Sloan; Model SU-1009
 - 3) Zurn; Model Z5755
 - 4) Toto; Model UT445U
 - 5) Kohler Company; Model K-4904-ET
 - b. ASME A112.19.2M; 0.125 gpf, vitreous china, wall hung wash-out urinal fixture with integral trap, 3/4" top spud, Disabled accessible.
2. Flush Valve (0.125gpf): Type 4FV.
3. Urinal Carriers: See CARRIERS.

2.3 WALL HUNG LAVATORIES

A. FIXTURE 'LV1'; LAVATORY (WH, ADA)

1. Lavatory Basin:
 - a. Manufacturers:
 - 1) Bradley; Verge with Washbar - Model LVQD1-WB1-T-5-PC-L-HD1-DR1
 - b. ASME A112.19.2M; Natural quartz bio-resin made of 25% recycled material, wall hung, 29.75" x 21" fixture with two hole drilling for washbar faucet. Fixture to include Bradley Washer Bar with integral faucet, soap dispenser, and hand dryer. Faucet to be sensor operated at 0.5GPM with Chrome Plated Finish and a below deck thermostatic mixing valve that meets ASSE 1070. Liquid Soap Dispenser.
2. Accessories:
 - a. Faucet: Included with Fixture.
 - b. Drain: Included with Fixture.
 - c. Supplies: See SUPPLY STOPS.
 - d. Trap: Type 1T; See TRAPS.
 - e. Carrier: Included with Fixture.

2.4 COUNTER MOUNTED SINKS

- A. FIXTURE 'SK1'; SINK (SS, CT, 22" x 22" SC, ADA)
 - 1. Sink:
 - a. Manufacturers:
 - 1) Elkay; Model LRAD-2222
 - 2) Just; Model SL-ADA-2222-A-GR
 - 3) Advance-Tabco; Model SS-1-2222-ADA
 - b. ASME A112.19.3M; 18 gauge, type 304 stainless steel, single compartment 22 x 22 x 6 -inches overall with 4 -hole drilling for faucet, 3-inch drain opening; ADA accessible.
 - 2. Accessories:
 - a. Faucet: Type 8F; See FAUCETS.
 - b. Drain: Type 4D; See DRAINS.
 - c. Supplies: Type SS1. See SUPPLIES.
 - d. Trap: Type 2T; See TRAPS.
 - e. Insulation: See FIXTURE INSULATION.
- B. FIXTURE 'SK2'; LAB SINK
 - 1. Sink: Provided in lab furnishings.
 - 2. Accessories:
 - a. Faucet: Provided in lab furnishings.
 - b. Drain: Provided in lab furnishings.
 - c. Supplies: Type SS3; See SUPPLIES.
 - d. Trap: Type 3T; See Traps.
 - e. Eyewash: Provided by casework manufacturer. Plumbing Contractor to install.(Refer to Lab plans for locations.)
- C. FIXTURE 'SK3'; LAB SINK
 - 1. Sink: Provided in lab furnishings.
 - 2. Accessories:
 - a. Faucet: Provided in lab furnishings.
 - b. Drain: Provided in lab furnishings.
 - c. Supplies: Type SS3; See SUPPLIES.
 - d. Trap: Type 3T; See Traps.
- D. FIXTURE 'SK4'; CUPSINK for Fume Hood
 - 1. Cup Sink: Provided in lab furnishings.
 - 2. Accessories:
 - a. Faucet: Provided in lab furnishings.
 - b. Drain: Provided in lab furnishings.
 - c. Supplies: Type SS3; See SUPPLIES.
 - d. Trap: Type 3T; See Traps.

2.5 MOP BASINS and SERVICE SINKS

- A. FIXTURE 'MB1'; MOP BASIN (TERRI, FM 24" x 24" x 12")
 - 1. Mop Basin:
 - a. Manufacturers:

- 1) Acorn; Model TDF-24
 - 2) Fiat; Model TSB3000
 - 3) Stern-Williams; Model HL-1800
 - b. ASME A112.19.1M terrazzo stone, one piece basin, 24 x 24 x 12-inches overall with drop front, stainless steel cap on threshold, integral stainless steel grate with quick connect drain.
2. Accessories:
- a. Faucet: Type 11F; See FAUCETS.
 - b. Hose & Bracket: Type 12F; See FAUCETS.

2.6 MISCELLANEOUS FIXTURES

A. FIXTURE 'IMB1'; ICEMAKER SUPPLY BOX

1. Icemaker Box Assembly
 - a. Manufacturers:
 - 1) Guy-Gray; Model BIM 875AB
 - 2) Water-Tite; Model AB9700
 - b. 20-gauge steel with powder-coated white finish or polystyrene plastic; 1/2"-inch FIP inlet by 1/4"-inch outlet compression angle valve with 1/2"-inch MPT connection. Angle valve to be low-lead to comply with NSF-61.

2.7 EMERGENCY SHOWERS and EYE WASHES

A. FIXTURE 'ESEW1'; EMERGENCY SHOWER/EYEWASH

1. Manufacturers:
 - a. Haws; Model 8355WC
 - b. Speakman; Model SE-575-DP-238-TMV
 - c. Water Saver; Model SSBF2150
 - d. Guardian; Model GBF2150
 - e. ANSI Z358.1 and ANSI 117.1; ADA Recessed wall mounted combination shower/eyewash assembly; below ceiling chrome plated shower head with pull down lever activation. Pull down eyewash mounted in recessed cabinet; thermostatic mixing valve assembly for providing 'tepid water'.

2.8 ELECTRIC WATER COOLERS

A. FIXTURE 'EWC1'; ELECTRIC WATER COOLER (HI-LO w/Bottle Filling Station)

1. Water Cooler
 - a. Manufacturers:
 - 1) Elkay; Model LZSTL8WSLK
 - 2) Haws; Model
 - 3) Halsey-Taylor; Model
 - 4) Oasis; Model P8SBFSL
 - b. ARI-1010; Bi-level, with ADA unit on the right, wall mounted electric water cooler assembly with stainless steel water surfaces, heavy duty galvanized steel wall mounting frame, 'sandstone' paint or vinyl finish cabinet, elevated anti-squirt bubblers with stream guard, automatic stream regulators;

front and side push button actuators; high efficiency cooling tank and air cooled coil delivering 8.0 gph 50-degree water at 90-degree ambient air temperature; with ADA compliant bottle filling station. Bottle filling station to have no touch sensor activation with 30 second shut-off timer, filter, and 1.1 gpm flow rate.

2. Accessories:
 - a. Supply: See SUPPLY STOPS
 - b. Trap: Type 1T; See TRAPS
 - c. Carriers: See CARRIERS

2.9 FIXTURE ACCESSORIES

A. FLUSH VALVES

1. Type 2FV (Standard & ADA Electronic Water Closet Valve- Diaphragm Type)
 - a. Manufacturers:
 - 1) Sloan; Regal Optima 111-1.28-SMO-YBYC-YK-XL
 - 2) Zurn 'Aqua Vantage-Aqua Sense'; Model ZER6000AV-HET-CPM-YK
 - b. ASME A112.18.1; Exposed chrome plated diaphragm type with 6VDC-4AA battery powered infrared sensor operated flush valve with heavy duty cast escutcheon with set screw, integral screwdriver stop, vacuum breaker; 1 1/2 inch top spud, 11 1/2-inches high; 1 solid-ring support; 1.28gpf maximum flush.
2. Type 4FV (Standard & ADA Electronic Urinal Valve- Diaphragm Type)
 - a. Manufacturers:
 - 1) Sloan; Regal Optima 186-0.125-SMO-YBYC-YK-XL
 - 2) Zurn 'Aqua Vantage-Aqua Sense'; Model ZER6003AV-ULF-CPM-YK
 - b. ASME A112.18.1; Exposed chrome plated diaphragm type with 6VDC-4AA battery powered infrared sensor operated flush valve with heavy duty cast escutcheon with set screw, integral screwdriver stop, vacuum breaker; 3/4 inch top spud, 11 1/2-inches high; 1 solid-ring support; 0.125gpf maximum flush.

B. SEATS

1. Type 1St.; Seat (Elongated, open front, less lid, white)
 - a. Manufacturers:
 - 1) Bemis; Model 1655SSC
 - 2) Plumbtech; Model 431SSC
 - 3) Kohler; Model K-4666-S-C
 - 4) Church; Model 9500SSC
 - 5) Centoco; Model 1500 series
 - 6) Zurn; Model Z-5955-SS-EL
 - b. Extra heavy weight, injection molded solid plastic, open-front, less lid, molded bumpers, external check hinges and stainless steel posts.

C. FAUCETS

1. Type 8F (8-inch spread single lever w/spray - Sinks)
 - a. Manufacturers:
 - 1) American Standard; Model 4205.001
 - 2) Delta; Model 400LF-HDF
 - 3) Elkay; Model LK-4101-F
 - 4) Encore; Model KN81-2010-TE1
 - 5) Just; Model J-901

- 6) Kohler; Model K-15072-CP
- 7) Speakman; Model S-3762-HS
- 8) T&S Brass; Model B-2730
- 9) Zurn; Model Z82300-XL-CP8-HS
- b. ASME A112.18.1M; Chrome plated brass double service, 8-inch widespread, single lever w/hose spray, swivel spout with aerator; 1.5 gpm.
2. Type 11F (w/ integral check stops and vacuum breaker - Mop Basin)
 - a. Manufacturers:
 - 1) American Standard; Model 8354.112.004
 - 2) Delta; Model 28C8183
 - 3) Speakman; Model SC-5812-RCP-CK
 - 4) Symmons; S-2490
 - 5) T&S Brass; B-0665-BSTR
 - 6) Zurn; Model Z843M1--XL-CS
 - b. ASME A112.18.1M; Rough Chrome plated brass exposed yoke wall-mount utility faucet assembly with integral stops and vacuum breaker, bucket hook, and threaded hose end, rough chrome finish.
3. Type 12F (Mop Basin Hose and Bracket)
 - a. Manufacturers:
 - 1) Acorn-Terrazzo; Model KH36
 - 2) Aquaglass AT-2452
 - 3) Fiat 832-AA
 - 4) Stern-Williams T-35
 - 5) Zurn; Model Z-1996 HH

D. DRAINS

1. Type 4D (Basket off-set drain - Sinks)
 - a. Manufacturers:
 - 1) EBC; Model SB8CWC
 - 2) Elkay; Model LKAD-35
 - 3) Just; Model J-ADA-35
 - 4) McGuire; Model 1151AWC
 - 5) Zurn; Model Z-8749
 - b. ASME A112.18.1M; 1 1/2" inch diameter chrome plated brass removable stainless steel strainer/drain assembly with offset 20-gauge tailpiece.

E. SUPPLY STOPS

1. Type SS1 (3/8"-inch, 1/4 turn; Loose Key; Lavatories/Sinks/Electric Water Coolers)
 - a. Manufacturers:
 - 1) Brasscraft; Model KTSR17XC
 - 2) Chicago; Model 1006-MMABCP
 - 3) McGuire; Model LFHST02LK
 - 4) Zurn; Model ZH8822-XL-LR-LK-PC
 - b. ASME A112.18.1M; Chrome plated brass angle heavy duty stop or ball stop, removable actuator key; supply tubing and escutcheon plate.

F. TRAPS

1. Type 1T (1 1/4"-inch Adj. 'P')
 - a. Manufacturers:
 - 1) EBC; Model TA-125-CF

- 2) Dearborn; Model 707 DFBN
- 3) Kohler; Model K-9000
- 4) McGuire; Model 8872
- 5) Zurn; Model Z-8700
- b. ASME A112.18.1M; Chrome plated cast brass, 17-gauge P-trap assembly with cast brass nuts, cleanout plug and heavy duty escutcheon.
2. Type 2T (1 1/2"-inch Adj. 'P')
- a. Manufacturers:
 - 1) EBC; Model TA-150-CF
 - 2) Dearborn; Model 710 GDFBN
 - 3) Kohler; Model K-9000
 - 4) McGuire; Model 8912
 - 5) Zurn; Model Z-8702
- b. ASME A112.18.1M; Chrome plated cast brass, 17-gauge P-trap assembly with cast brass nuts, cleanout plug and heavy duty escutcheon.
3. Type 3T (1 1/2"-inch Acid Neutralization Type)
- a. Manufacturers:
 - 1) Zurn; PHIX Chemical Acid Neutralization System
- b. Polypropylene Housing with 1 1/2" Drain connection. Housing contains sediment bucket and acid neutralization cartridge with 1 1/2" no hub outlet. Provide replacement media bucket.

G. CARRIERS

1. Water Closets
 - a. Type C1
 - 1) Manufacturers:
 - (a) Josam; Model 12674 or 12684
 - (b) JR Smith; Model 210-L/R-Y
 - (c) Mifab; Model MC-10 L/R
 - (d) Wade; Model 310-NL/R
 - (e) Watts; Model CA-101-L/R
 - (f) Zurn; Model Z-1203-NL/R4
 - b. Type C1a
 - 1) Manufacturers:
 - (a) Josam; Model
 - (b) JR Smith; Model 0208 L/R/D-Y
 - (c) Mifab; Model
 - (d) Wade; Model
 - (e) Zurn; Model Z-1203-NL/R3
 - c. Type C2
 - 1) Manufacturers:
 - (a) Josam; Model 12694
 - (b) JR Smith; Model 220-D-Y
 - (c) Mifab; Model MC-10D-36
 - (d) Wade; Model W-310-ND
 - (e) Watts; Model CA-101-D
 - (f) Zurn; Model Z-1203-ND4
 - d. Type C3
 - 1) Manufacturers:

- (a) Josam; Model 12764 or 12774
 - (b) JR Smith; Model 240-L/R-Y
 - (c) Mifab; Model MC-13-L/R
 - (d) Wade; Model W-340-NL/R
 - (e) Watts; Model CA-131-L/R
 - (f) Zurn; Model Z-1204-1NL/R4
- e. Type C4
- 1) Manufacturers:
 - (a) Josam; Model 12734
 - (b) JR Smith; Model 230-Y
 - (c) Mifab; Model MC-12
 - (d) Wade; Model W-330-NL
 - (e) Watts; Model CA-121
 - (f) Zurn; Model Z-1204-N4
- f. Type C5
- 1) Manufacturers:
 - (a) Josam; Model 12724
 - (b) JR Smith; Model 230-D-Y
 - (c) Mifab; Model MC-12D
 - (d) Wade; Model W-330-ND
 - (e) Watts; Model CA-121-D
 - (f) Zurn; Model Z-1204-ND4
- g. Type C6
- 1) Manufacturers:
 - (a) Josam; Model 12794 or 12804
 - (b) JR Smith; Model 250-Y
 - (c) Mifab; Model MC-13-2
 - (d) Wade; Model W-340-ANL/R
 - (e) Watts; Model CA-131-2
 - (f) Zurn; Model Z-1204-2N4
- h. Type C7
- 1) Manufacturers:
 - (a) Josam; Model 12764 or 12774
 - (b) JR Smith; Model 240-L/R-Y
 - (c) Mifab; Model MC-13-L/R
 - (d) Wade; Model W-340-NL/R
 - (e) Watts; Model CA-131-L/R
 - (f) Zurn; Model Z-1204-1NL/R4
- i. Type C8
- 1) Manufacturers:
 - (a) Josam; Model 12814
 - (b) JR Smith; Model 250-D-Y
 - (c) Mifab; Model MC-13D-2
 - (d) Wade; Model W-340-AND
 - (e) Watts; Model CA-131-D2
 - (f) Zurn; Model Z-1204-2ND4
- j. Type C9
- 1) COMPACT NOHUB VERTICAL OFFSET; NO INLET
 - 2) Manufacturers:

- (a) Josam; Model 14404 or 14424
 - (b) JR Smith; Model 0410LY or 0410RY
 - (c) Mifab; Model MC-15 or
 - (d) Wade; Model 371L or 371R
 - (e) Watts; Model ISCA-151-L or ISCA-151-R
 - (f) Zurn; Model Z1209I or Z1209R
- k. Type C10
- 1) Manufacturers:
 - (a) Josam; Model 12700-XSD
 - (b) JR Smith; Model 0240Y-M58-M54-XX
 - (c) Mifab; Model
 - (d) Wade; Model 330-XB
 - (e) Watts; Model ISCA-122
 - (f) Zurn; Model Z1204-N-XH
- l. Type C11
- 1) Manufacturers:
 - (a) Josam; Model 12724-XSD
 - (b) JR Smith; Model 0240DY-M58-M54-XX
 - (c) Mifab; Model
 - (d) Wade; Model 330-ND-XB
 - (e) Watts; Model ISCA-122-D
 - (f) Zurn; Model
2. Urinals
- a. Type C9
 - 1) Manufacturers:
 - (a) Josam; Model 17800-63
 - (b) JR Smith; Model 636
 - (c) Mifab; Model MC-31
 - (d) Wade; Model W-400-M36
 - (e) Watts; Model CA-311-Std.
 - (f) Zurn; Model Z-1221
3. Lavatories
- a. Type C10 'Single'
 - 1) Manufacturers:
 - (a) Josam; Model 17100-63
 - (b) JR Smith; Model 700-M31
 - (c) Mifab; Model MC-41
 - (d) Wade; Model 520-36
 - (e) Watts; Model CA-411-Std.
 - (f) Zurn; Model Z-1231-D
4. Carrier Notes:
- a. Carriers shall be manufactured in accordance with ASME A112.18.2 standards.
 - b. All single water closet carriers shall be provided with an anchor foot assembly unit. Unit shall be secured to the floor per manufacturer's instructions.
 - c. All carriers shall be bolted to the floor with lag bolts.
 - d. All lavatory, urinal and water cooler supports shall have heavy duty rectangular supports.

- e. Carriers shall be provided where fixture is mounted on chase wall or mechanical room wall.
- f. Auxiliary face plate shall be utilized when the face plate of the carrier is more than 4-inches from the back of the water closet (stud walls) or more than 4-inches from the inside face of the wall (masonry walls).

H. FIXTURE INSULATION

- 1. Manufacturers:
 - a. EBC; Model IK Series
 - b. McGuire; Model 'Pro-Wrap' Series
 - c. Plumberex; Model Pro Extreme Series
 - d. Proflo; Model PF200 Series
 - e. True-Bro; Model 'Lav Guard' Series
 - f. Zurn; Model 'Trap Wrap' Series
- 2. Insulation assembly shall be for supply stops & tubing; drains (including off-sets) and P-traps under all ADA lavatories and counter sinks.
- 3. ANSI A117.1, ADA4.19.4; Fully molded, anti-bacterial flexible vinyl insulation assembly, minimum 1/8"-inch wall thickness, white in color, self-extinguishing meeting ASTM D635, and have a K-value of 1.17.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.
- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons, as specified in Fixture Accessories.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.
- E. Seal wall and floor mounted fixtures to wall and floor surfaces with silicon latex tile grout. Joints shall be finished smooth and flush, not depressed. Color to match fixture.

- F. Solidly attach water closets to closet flange with solid brass bolts, washers and nuts. Provide wax ring sealant on closet flange. Lead flashing shall not be used.
- G. Pipe runout from urinal to waste stack shall be Brass or Schedule 40 PVC piping. Copper piping shall not be used.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING AND PROTECTION

- A. Clean plumbing fixtures and equipment.
- B. Do not permit use of fixtures.

3.7 SCHEDULES

- A. Refer to Fixture Schedule on plans for mounting heights and piping connections.

END OF SECTION 22 4010

SECTION 22 6005 - LABORATORY AIR, GAS, AND VACUUM SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Laboratory compressed air system.
- B. Laboratory vacuum system.
- C. Specialty Gas system.

1.2 RELATED REQUIREMENTS

- A. Section 22 0510 - General Plumbing Requirements
- B. Section 22 1005 - Plumbing Piping
- C. Section 22 1006 - Plumbing Specialties
- D. Section 22 4010 - Plumbing Fixtures

1.3 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- C. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- D. ASME BPVC - Boiler and Pressure Vessel Code; 2015.
- E. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- F. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- G. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- H. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- I. CGA V-5 - Diameter Index Safety System (Noninterchangeable Low Pressure Connections for Medical Gas Applications); 2008.
- J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.
- K. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

- L. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; 2013.
- M. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.

1.4 SUBMITTALS

- A. Refer to Section 22 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.
- C. Shop Drawings: Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels. Submit detailed medical wall assembly drawings.
- D. Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.
- E. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for Air Compressor.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

- A. Compressed Air and Specialty Gases, Aboveground:
 - 1. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn.
 - 2. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper.
 - 3. Joints: AWS A5.8M/A5.8 Classification BCuP-3 or BCuP-4 silver braze.
- B. Vacuum Systems, Aboveground:
 - 1. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn.
 - 2. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper.
 - 3. Joints: AWS A5.8M/A5.8 Classification BCuP-3 or BCuP-4 silver braze.

2.2 VALVES

- A. Factory Preparation for Oxygen Service: Disassemble, clean, degrease, seal, and pack for shipping.
- B. Ball Valves:
 - 1. Requirements: Comply with MSS SP-110; bronze body, three piece, double-seal ball valves with replaceable neoprene or teflon seat and stem seals, for minimum 600 psi cold working pressure, flange or union mounting, labeled for intended service.

2.3 SPECIALTY GAS MANIFOLD

- A. Manufacturers:
 - 1. Allied Healthcare Products, Inc.:
 - 2. Amico Corporation;
 - 3. BeaconMedaes:
 - 4. Powerex Inc.
 - 5. Western Enterprises; Model MS-2-2
- B. Manual Manifold: Maximum working pressure 3000psig, with brass headers and 24" stainless steel pigtailed with check valves. Manifold to have 1/2" outlet.

2.4 OIL FREE SCROLL AIR COMPRESSOR (AC-1)

- A. Manufacturers:
 - 1. Atlas Copco
 - 2. Quincy Compressors
 - 3. Kobelco Compressor
 - 4. Patton Medical:
 - 5. Powerex Corporation; Model STD0504:
 - 6. Beacon Medaus
- B. Oil-less Scroll Compressors: Duplex Compressor assembly shall be constructed of one fixed and one orbiting scroll sealed with PTFE tip seals between scroll halves. Each compressor shall be oil-less rotary single stage, air cooled, oil-less design with no oil needed for operation. Orbiting bearings shall be grease filled and Drive bearings shall be grease filled and lip sealed and field serviceable. Housing shall be constructed of die cast aluminum. Integral cooling fan and air ducting for heat dissipation. Air-cooled aftercoolers for each compressor module with maximum temperature of 15 degrees F and automatic solenoid drain valves. Each compressor shall include a discharge check valve of brass construction, an ASME safety relief valve, intake and discharge flexible connectors, a solenoid valve discharge line unloader, an isolation valve, and a high discharge temperature shut-down switch on each cylinder.
- C. Air Dryer:
 - 1. Type: Self-contained mechanical refrigeration type complete with heat exchanger, refrigeration compressor, automatic controls, moisture removal trap, internal wiring and piping, and full refrigerant charge.

2. Air Connections: Inlet and outlet connections at same level, factory insulated.
 3. Heat Exchangers: Air to air and refrigerant to air coils. Provide heat exchangers with automatic control system to bypass refrigeration system on low or no load condition.
 4. Moisture Separator: Centrifugal type located at discharge of heat exchanger.
 5. Refrigeration Unit: Hermetically sealed type to operate continuously to maintain specified 38°F dew point. House unit in steel cabinet provided with access door and panel for maintenance and inspection.
 6. Accessories: On/off switch, high temperature light and power on light.
 7. Capacity:
 - a. Rated Air Flow: 30 cfm.
 - b. Inlet Air Pressure: 100 psi.
- D. Final Air Filter downstream from refrigerated air dryer, Coalescing filter rated to .01Micron.
- E. 120 Gallon Air Receiver Tank rated for 200psi working pressure. Tank to have sight gauge, safety relief valve, pressure gauge and automatic moisture drain.
- F. Capacity:
 1. Continuous Delivery: 30.4 cfm of free air total for compressor assembly.
 2. Intake Conditions: 95 FDB and 78 FWB.
 3. Discharge Conditions: 100 psig with package capacity of 30.4 ACFM at 100 psig
- G. Electrical Characteristics:
 1. 5 hp each compressor. 10HP Total.
 2. 460 volts, three phase, 60 Hz.

2.5 PRESSURE REDUCING VALVE

- A. Manufacturer: ARO; Model 2734-7-2-0-0.
- B. Other acceptable manufacturers offering equivalent products.
- C. Pressure Reducing Station: Consisting of automatic reducing valve and bypass, and low pressure side relief valve and gage.
- D. Valve Capacity: Reduce pressure from 200 psi to 30 psi, adjustable upwards from reduced pressure.

2.6 VACUUM PUMPS

- A. Manufacturers:
 1. Vacuubrand; Model MD 4C NT
 2. BrandTech Scientific
 3. KNF

- B. System: Continuous Oil Free pumping of gases and vapors. Three stage design, diaphragm pump. All seals, diaphragms and tubes shall be resistant to corrosive gases. Run vent to fume hood exhaust.
- C. Performance: 2.2cfm at Max Speed. Ultimate Vacuum 1.1 Torr
- D. Electrical: 1/3 HP at 120V.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Braze joints in pipe and tubing. Avoid leaving excess flux inside of pipe and fittings. During brazing of pipe connections, purge interior of pipe continuously with nitrogen.
- B. Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.
- C. Cut pipe and tubing accurately and install without springing or forcing.

3.2 PIPING SYSTEMS CLEANING AND PRESSURE TESTING

- A. After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.
- B. Install service outlet valves, subject system to test pressure of 150 psi with nitrogen or dry compressed air. Check with soapy water. Provide 24-hour standing pressure test.

END OF SECTION 22 6005

SECTION 23 0510 - GENERAL MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Definitions.
- B. Quality Assurance Requirements and Installer Qualifications.
- C. General Product Delivery and Storage.
- D. Installer Warranty.
- E. Regulatory Requirements indicating applicable Codes, Ordinances and Regulations.
- F. Submittal Procedures Supplementing Section 01 3300.
- G. Mechanical Shop Drawing Requirements.
- H. Operating and Maintenance Manuals.
- I. Execution Requirements common to Division 23 systems.
- J. Mechanical sleeve seals.
- K. Manufactured roof curbs(not specified with equipment) and equipment rails.
- L. Prefabricated pipe curb.
- M. HVAC Demolition.
- N. Existing HVAC systems.
- O. Pipe Sleeves within building.
- P. Pipe Sleeves in footings and foundations.
- Q. Space Conditioning during Construction.
- R. Piping Pressure Tests.
- S. Equipment Bases and Housekeeping Pads.
- T. Equipment backboards.
- U. Starting equipment and Systems-General Requirements.
- V. Training Requirements.
- W. Cleaning Requirements.

X. Finishing Requirements.

1.2 RELATED SECTIONS

- A. Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Section 01 7300 - Execution.
- C. Section 01 9100 - General Commissioning Requirements.
- D. Section 03 3000 - Cast-in-Place Concrete.
- E. Section 07 8413 - Penetration Firestopping.
- F. Section 07 9000 - Joint Sealers.
- G. Section 09 9123 - Interior Painting.
- H. Section 23 0800 - Commissioning of HVAC System.

1.3 DEFINITIONS

- A. Manufacturer's Representatives: Wherever MANUFACTURER'S REPRESENTATIVE is referred to in this division, said representative shall be regularly employed by the manufacturer to perform similar activities to those called for herein, which indicates his competence in that field of work.
- B. Concealed: Where the word concealed is used in this Division, it shall mean items above ceilings, in crawl spaces, in chases, in tunnels, in cabinet work, and under counters or equipment so as to be not visible from an elevation of 5 feet at a horizontal distance of 10 feet.
- C. Finished Spaces or Areas: Where finished spaces or areas are referred to in this Division, it shall mean all spaces except concealed spaces, mechanical rooms, or boiler rooms unless otherwise noted.
- D. Provide: Furnish and install.
- E. Control and Interlock Wiring: All wiring, both line voltage and low voltage, other than power wiring from an electrical distribution panel, through the primary control device, to the item of equipment.
- F. Primary Control Device: That ONE device for any item of equipment which interrupts power flow during normal operation. Where magnetic starters are provided, they are the primary control. For items not switched by starters, the primary control device will be that ONE thermostat, time clock, manual switch, aquastat, P.E. switch, or relay performing the primary switching.
- G. Diagrammatic: A drawing that shows arrangement and relations (as of parts).i.e.: A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts,

conduit and other items shown and is not necessarily to scale. Arrangement, location, and sizes shown are firm.

- H. Readily Accessible: Items requiring maintenance shall be available for close approach for maintenance or use in a space, through an access door from floor elevation, or above a lay-in ceiling through an access point by maintenance staff safely standing on a ladder no taller than the ceiling.
- I. Noted, Indicated or Shown: Where the terms "Noted", "Indicated" or "Shown" are used in these specifications, the words "in the specifications or on the plans" shall be inferred.
- J. Detail: Where reference is made to a Detail, the Detail shall be on the plans unless otherwise noted.
- K. Specifications: Where reference is made to these specifications, it shall be inferred in this Division of specifications.
- L. Notification by the Contractor, and Instructions to the Contractor: Where reference is made in these specifications to notification by or instructions given to the Contractor, it shall be inferred that Architect shall be the instructor or shall be notified, as the case exists.
- M. Division or Section Reference: Where reference is made to another Division or Section within this Division, refer to specifications table of contents for Division, Section, or Page Number.
- N. Flow Diagram: A single-line, two-dimension, non-scaled drawing depicting arrangement and sequence of equipment, valves, controls, thermometers, gauges, and other specialty devices in a pipe or duct system.

1.4 REGULATORY REQUIREMENTS

- A. Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications.
- B. Materials and equipment included in Underwriters Label Service shall bear that label. Electrical equipment shall be U.L. approved as installed.
- C. Jurisdiction: Where codes or guides refer jurisdiction to local governing code officials, such official in this procedure shall be the City/County Building Officials.
- D. Permits: Obtain all permits, paying all fees in connection therewith. At completion, have work inspected by proper authorities and furnish Architect for Owner an inspection certificate showing approval of installation.
- E. Permits and Codes: Refer to the General Conditions.
- F. Fire Prevention Precautions in Cutting and Welding Areas: Conform to Article 2605 Fire Prevention Precautions, Georgia State Minimum Standard Fire Prevention Code (International Fire Code), 2018 Edition, with Georgia State Amendments, for all work involving cutting and welding.

- G. HVAC: Conform to the Georgia State Minimum Standard Mechanical Code (International Mechanical Code), 2018 Edition with Georgia State Amendments.
- H. Energy: Conform to the Georgia State Energy Code for Buildings (International Energy Conservation Code), 2015 Edition, with Georgia State Amendments.
- I. All Work: Conform to State of Georgia Chapter 120-3-3 "Rules of Safety Fire Commissioner, Rules and Regulations, August 27, 2020", and ADA.
- J. Electrical: Refer to Division 26. Conform to the National Electrical Code, NFPA 70, 2017 Edition.
- K. Building Code: Conform to the Georgia State Minimum Standard Building Code (International Building Code), 2018 Edition with Georgia State Amendments.

1.5 PERFORMANCE REQUIREMENTS

- A. Requirements specified herein are minimum. All equipment, when installed, shall perform equal to or exceed specified requirements.

1.6 SUBMITTALS

- A. Refer to Section 01330 - Submittals, for general submittal procedures.
- B. Quality Assurance Affidavits:
 - 1. HVAC Installer Qualifications
 - 2. Testing and Balancing Agency Qualifications
- C. Supplementing Division 1 administrative requirements; Contractor shall:
 - 1. Assemble the submittal data in complete sets in hard back three-ring binders, separated by trade, and bound with numbered index sheets and tabs by Specification Sections. Submittal data shall be submitted at one time unless unavailable data such as control submittal would delay project progress. Data shall include capacities, complete installation instructions, dimensional data and electrical data, BHP, motor HP, operating weights and load distribution at mounting points.
 - 2. Identify all submittals by a cover sheet showing project name, specification section, drawing or detail number, room number, date, revision date, contractor and subcontractor's organization and project manager with phone number, the model, style and size of item being submitted with manufacturers' representative, salesman (or a preparer who can answer questions), and Preparer's phone number.
 - 3. Prepare a master list of submittal proposed to be submitted on the project. This list shall be updated for each submission and shall be the first sheet(s) of the submission in the quantity that is submitted for review. The information and general format shall contain a Tab number, Item Description, Item Status and any comment.
 - 4. Review the submittal data and check to ensure compliance with specifications prior to submitting.
 - a. The Contractor agrees that submittals of equipment and material and shop drawings of equipment and material layouts required under provisions of these specifications and processed by Architect are not Change Orders. The purpose

- of submittals is to demonstrate that Contractor understands the design concept of the project by indicating the equipment and materials he intends to furnish and install, and by detailing the installation he intends to achieve.
- b. The Contractor shall conform to the requirements of the Contract Documents unless a change order is issued. The Contractor shall identify on each submittal and in letter form to Architect any and all deviations from the Contract Documents.
 - c. Any submittal or shop drawing not conforming to the Contract Documents without this identification and notification shall be assumed to be marked "Revise and Resubmit" (the contractor acknowledges this by the submission), and Contractor shall promptly resubmit said submittal so as to be in full compliance with the Contract Documents.
 - d. Failure of Contractor to provide this information during the shop drawing phase shall make Contractor responsible for all changes to achieve compliance with the Contract Documents without additional compensation.
5. Provide a Letter from the HVAC Contractor stating that they have checked all submittals for compliance with specifications.
 6. Product Data:
 - a. Provide data specific to the Product proposed indicating capacity data, all standard and optional features to be supplied and all accessories and options available for that product.
 - b. Manufacturer's standard drawings shall be modified by deletions or additions to show only items applicable to this project.
 7. Deliver submittals to Architect at the business address.
 8. Digital Delivery of Submittals:
 - a. Submittal data may be posted to the NBP Engineers FTP site when agreed upon by Architect and Owner during the preconstruction phase. Contractor will be provided with a project folder and a password.
 - b. Prepare the submittals as described above. Provide one pdf file for each specification section including all submittal data for that specification section. Provide labels identifying each piece of equipment, piping, or accessory to match the listed item in the specification. Take steps to reduce submittal file size.
 - c. Do not scan in color or high resolution unless required for clarity.
 - d. Ensure any reproductions are legible.
 - e. Send an email to submittal@nbpengineers.com with a copy to the HVAC Design Professional identified during the preconstruction phase.
 - f. Provide a submittal index and identify the submittal in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building-Section 230548-Vibration and Seismic Controls.
 - g. Ensure the submittal posted to the FTP site has the same identification.
 - h. NBP Design Professionals will not process or react to submittals which are not properly transmitted, indexed, and identified.

D. Shop Drawings:

1. General: Furnish shop drawings of each of the following systems:
 - a. Ductwork
 - b. HVAC Piping - Underground Utilities
 - c. HVAC Piping - Building

- d. Equipment Rooms
 - 1) HVAC Equipment, Ductwork, and Piping
2. Format and Content:
 - a. Shop drawings shall be complete and shall accurately show all items of equipment and material. The number of drawings, and the views contained therein, shall be as needed to show the actual and final routing, construction, and final assembly of each system.
 - b. All drawings shall be electronically produced in a BIM compatible format. Free-hand drawings are not acceptable.
 - c. All lettering shall be legible without use or aid of magnifying device. Title-block lettering shall be minimum 1/8".
 - d. Drawings shall be printed (or plotted) at either 24" high by 36" wide, or the same size as the Contract Drawings for the same trade, whichever is greater. Each drawing sheet shall be formatted the same as the Contract documents (i.e., border width, title block, etc.). With the exception of Isometric drawings, all other drawings shall be drawn in two-dimension and at the same scale as the Contract Drawing of the same area, or as follows, whichever is the larger scale:
 - e. Scale of drawings shall be as follows:
 - 1) Floor Plans 1/8" per foot
 - 2) Roof Plans 1/8" per foot
 - 3) Elevations 1/4" per foot
 - 4) Details 1/4" per foot
 - 5) Equipment Room Layouts 1/4" per foot
 - 6) Isometrics No scale
 - 7) Riser Diagrams 1/4" per foot
 - 8) Equipment Room Pad Layout 1/4" per foot
 - f. Three-dimensional views may be produced and used to provide supplemental information to that which is given on two dimensional drawings. Three-dimensional drawings shall be drawn from a 30-deg. perspective.
 - g. Each individual shop drawing sheet shall contain a single format (two-dimensional or three-dimensional).
 - h. In addition to the information called for in the Contract Documents provide all additional data and notations needed to show conformance with Contract Documents (i.e., air flow and volume from/to air devices).
 - i. For all drawings drawn in two-dimensions, all characteristics of the equipment, systems and components, shall be drawn to scale to designate actual size. Use of dimensions alone to designate width, height, length, or depth is not acceptable. Drawings shall not require that they be "scale" to determine sizes or location.
 - j. In the event either the project as a whole, or the specific area covered by a particular drawing, does not contain columns, floors and/or walls to which dimension reference can be made in the location of items, alternate fixed points of reference may be used.
 - k. Shop Drawings drawn at the same scale as the contract Drawings, shall incorporate the same floor plan or ceiling plan areas, and shall be arranged and be "broken" along the same lines as the Contract Drawings.
 - l. Duct and piping systems which have the following maximum width on one side shall be drawn in the following manner:
 - 1) Drawing Scale
 - 2) 1/4" per ft. =>4" Double-line

- 3) 1/4" per ft. <4" Single-line
- 4) Flexible duct Single-line to diffusers
3. Ductwork Shop Drawings:
 - a. Background information shall be redrawn scaled versions of the Architectural floor or Reflected Ceiling Plans of the Contract Drawings and shall show all partitions, openings, and structural features. Drawings from the Contract Documents shall not be copied for use as backgrounds nor will reproducible drawings be made available from the Architect for this purpose.
 - b. Show fitting joints, fittings, equipment, required maintenance, removal and safe working clearances, elevations, location and sizes of access panels, net sizes (size of system less insulation), dimension from finished floor and/or overhead structure, horizontal dimension from centerline of columns, direction of flow, changes in size, changes in external covering, system material, construction classification, system name, internal liner, unique situations, equipment designation.
 - c. Show floor plan location of all space control and sensing devices (thermostat, humidistats, CO2 sensors etc.) complete with the designation of the piece of equipment or component which device controls. Lines drawn between the sensing device to the controlled equipment or component, to designate their interaction, are not acceptable.
 - d. Sheet metal work shall be drawn using symbols and designations in accordance to the latest edition of "SMACNA" Duct Construction Standards - Metal and Flexible".
4. HVAC Piping - Underground Utilities Shop Drawings:
 - a. Refer to Section 23 2140.
5. HVAC Piping - Building Shop Drawings:
 - a. Background shall be the Ductwork Shop Drawings called for elsewhere in this Section except that notes and details pertinent to only ductwork may be omitted.
 - b. Show flanges, fittings, equipment, locations and sizes of access panels, required maintenance, removal and safe working clearances, elevations, net size (size of system less thermal or acoustical coverings), dimension from finished floor and/or overhead structure, horizontal dimension from centerline of columns, grade, percent of slope and/or rate of change, direction of flow, changes in size, changes in external covering, system material, construction classification, system name or symbol, unique situations, equipment designation.
 - c. Show floor plan location of all space control and sensing devices (thermostats, humidistats, CO2 sensors) complete with the designation of the piece of equipment or component which device controls. Lines drawn between the sensing device to the controlled equipment or component, to designate their interaction, are not acceptable.
 - d. Piping shall be drawn utilizing the symbols and designations of the controls standards, providing those standards are in general compliance with Industry Standards (i.e. ASHRAE, ANSI, etc.). Provide piping symbol legend on shop drawing.
 - e. Each piece of equipment or manufactured product shall bear the same designation as indicated on the contract documents.
6. Equipment Room Shop Drawings:

- a. Background shall be redrawn scaled versions of the Architectural Floor Plan showing all partitions, openings, and structural features.
 - b. Show actual size and location of equipment in both plan and vertical section, laid out on center line of equipment shown.
 - c. Equipment and equipment pads shall be drawn to scale and dimensioned. Dimensions shall conform to actual manufacturer's dimensions for product used.
 - d. Show dimensions of equipment placing relative to partitions, columns, beams, and underside of structural deck.
 - e. Show and dimension all service clearances, access door swings, vertical clearances.
 - f. Show all piping, ducts, and equipment to provide full information for coordination.
 - g. Show electrical panels to scale including control panels and disconnect switches.
- E. Tabulation of Power Wiring Requirements: Within 60 Days of the Notice to Proceed, provide a Tabulation of Power Wiring Requirements of all proposed equipment, including H.P., amps, voltage, phase and KW, tabulated on a separate sheet. A copy of the tabulation shall be transmitted independently to the Contractor, Architect and to all affected trades. (Refer to Electrical Drawings for electrical provisions for equipment.)
- F. Piping Pressure Tests - Submit the following:
1. Hydrostatic Testing Records: The Contractor shall maintain an updated log of pressure tests (as described in this Section) available to the Owner and Design Professional at all times. The Contractor shall submit a final log to the Owner for record.
 2. Submit affidavit of pressure test compliance to Design Professional.
- G. Warranty: Submit the HVAC installer's warranty letter addressed to Owner stating the correct project name and number, if applicable, the warranty period and ensure that form has the correct date of Material Completion.

1.7 OPERATING AND MAINTENANCE MANUALS

- A. Operating and maintenance Manuals shall be prepared by Contractor for all equipment and be submitted for review a minimum of two months prior to Substantial Completion.
- B. Digital Delivery of Operating and Maintenance Manuals:
1. Operating and Maintenance Manuals may be delivered digitally and posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and password.
 2. Prepare the Operating and Maintenance Manuals as described above. Take steps to reduce submittal file size.
 3. Do not scan in color or high resolution unless required for clarity.
 4. Ensure any reproductions are legible.
 5. Send an email to submittal@nbpengineers.com with a copy to the HVAC Design Professional identified during the preconstruction phase.

6. Identify the manuals in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building.
 7. Table of Contents(Index) sheets shall be included in the order listed with identifications typed in capital letters.
 8. Ensure the manuals posted to the FTP site has the same identification.
 9. NBP Design Professionals will not process or react to manuals which are not properly transmitted, indexed, and identified.
- C. Physical Delivery of Operating and Maintenance Manuals:
1. Three (3) bound and indexed Operating and Maintenance Manuals shall be prepared by Contractor for all equipment and be submitted for review a minimum of two months prior to Material Completion. Two (2) approved copies shall be delivered to the Using Agency at the final inspection.
 2. Data shall be bound in smooth surface hard back commercial quality three-ring notebooks with project identification shown on the front cover and binding back. Identification labels shall be typed and adhered with waterproof glue.
 3. Notebooks shall have 9-1/2-inch by 11-1/2-inch covers with back width to permit the covers to lie parallel or to converge, and have not less than 1-1/2-inch back width.
 4. Index divider sheets of heavy Manila paper shall be inserted between each section of the Manual with a 2-inch x 1/3-inch ready-cut shield tab attached to each sheet for identification of sections.
 5. Data sheets and diagrams shall be 8-1/2-inch x 11-inch or be mounted on 8-1/2-inch x 11-inch sheets of 16-pound paper if smaller, with reinforced 11-inch mechanically perforated edges. Drawings and diagrams larger than 8-1/2-inch by 11-inch shall be folded up from the bottom to form a height of 11-inches and folded to the left to form a width of 8-1/2-inches.
 6. Table of Contents(Index) sheets shall be provided in the order listed with identifications typed in capital letters.
- D. Each Manual shall contain the following information, data and drawings:
1. Copies of submittals (with Design Professional's review comments and stamp), equipment and materials.
 2. Manufacturer's make, model, and serial number for each item of equipment shall be identified.
 3. Equipment performance curves for all fans, pumps, valves, flow monitoring stations, air terminal units, etc.
 4. Manufacturer's installation, operating and maintenance instructions for each item of equipment with moving parts including recommended frequency of inspections and maintenance for one year of facility operation.
 5. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
 6. Control diagrams, electrical interlock diagrams, and control valve lists.
 7. Manual shall include all setup procedures, calibration settings, setup parameters, and final settings for all equipment, drives, instrumentation, etc.
 8. Print copies of as-built HVAC shop drawings showing layouts and construction details.
 9. Electronic files on CD of as-built shop drawings showing layouts and construction details.

10. Copies of Test and Balance Reports including list of instruments and description of methods employed.

1.8 QUALITY ASSURANCE

A. HVAC Installer Qualifications:

1. Wherever the word "company" or "firm" is used in these subparagraphs, it shall mean the contractor/subcontractor of record for the installations used for proficiency qualification.
2. Refer to the individual sections within this division for additional installer qualification requirements.
3. The Mechanical Contractor performing the installation of the air conditioning systems has demonstrated proficiency in the installation, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least three similar commercial or institutional buildings, each containing a minimum of 250 tons capacity or greater with ducted supply/exhaust air distribution and chilled water or water source heat pump systems.
4. The Contractor further warrants that the aforesaid subcontractor has trained personnel, instruments, tools, and equipment to perform the installation, start-up, instruction and maintenance service specified.
5. The Contractor also warrants that the aforesaid installer has been in business performing services of the nature specified herein for at least five (5) years.

B. Testing and Balancing Agency Qualifications:

1. The Contractor expressly warrants that the company performing the Testing and Balancing of the air conditioning systems has demonstrated proficiency in the testing, balancing, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least Twenty (20) commercial or institutional buildings, each containing minimum of 250 tons capacity or greater with ducted air distribution and chilled water or water source heat pump systems.
2. The contractor further warrants that the aforesaid subcontractor has trained personnel, instruments, tools, and equipment to perform the testing and balancing specified.
3. The contractor also warrants that the aforesaid installer has been in business performing services of the nature specified herein for at least five (5) years.

HVAC AFFIDAVIT

THIS IS TO CERTIFY pursuant to the General Conditions that [insert name of installer], Mechanical subcontractor of the undersigned, has demonstrated proficiency in the installation and adjustment of HVAC systems by the successful performance of HVAC work of the nature specified in the bidding documents for at least three similar commercial or institutional buildings, each containing a minimum of 250 tons, the foregoing installations having been the complete and undivided responsibility of the Mechanical subcontractor.

List at least three showing name and address of each Project:

- (1)
- (2)
- (3)

THE CERTIFICATIONS of the affiant are not mere declarations but are in consideration of and in fulfillment of express contractual requirements established in the bidding documents for construction of Project _____.

THIS AFFIDAVIT applies to Project _____.

This day of , 2020.

NAME OF COMPANY:

By:

Title:

CERTIFICATE OF NOTARY PUBLIC

Sworn and subscribed to before me, an officer authorized to administer oaths.

This day of , 2020.

Notary Public

My commission expires on _____.

TEST AND BALANCE AGENCY AFFIDAVIT

THIS IS TO CERTIFY pursuant to the General Conditions that [insert name of firm], Testing and Balancing subcontractor of the undersigned, has demonstrated proficiency in the testing, balancing, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least twenty (20) commercial or institutional buildings, each containing a minimum of 250 tons capacity or greater with ducted air distribution and chilled water or water source heat pump systems.

List at least twenty showing name and address of each Project:

(1) - (20)

Provide a complete set of the Test and Balance report forms to be used for the project, with a complete listing of all equipment to be tested, adjusted and balanced; and provide a listing of all air flow, water flow, system capacity and efficiency measurements to be performed.

THE CERTIFICATIONS of the affiant are not mere declarations but are in consideration of and in fulfillment of express contractual requirements established in the bidding documents for construction of Project _____.

THIS AFFIDAVIT applies to Project _____.

This day of , 2020.

NAME OF COMPANY:

By:

Title:

CERTIFICATE OF NOTARY PUBLIC

Sworn and subscribed to before me, an officer authorized to administer oaths.

This day of , 2020.

Notary Public

My commission expires on _____.

- C. Testing and Balancing Agency: Refer to Section 23 0593.

1.9 PRODUCT DELIVERY, STORAGE, AND PROTECTION

- A. Accept all products on site in factory-fabricated protective containers. Inspect for damage.
- B. Store products in a clean dry place and protect from weather and construction traffic.
- C. Handle products carefully to avoid damage to components, enclosures, and finish.
- D. After placement, protect products from damage during construction, by all trade contractors.
- E. Protect equipment nameplates and labels from damage, being painted, scaring, etc.

1.10 WARRANTY

- A. Refer to Section 01 7000 - Execution Requirements, for additional warranty requirements.
- B. Refer to Articles E-19 and E-20.
- C. Submit manufacturers' warranties prior to final inspection. Refer to the General Conditions.
- D. Correct any defective Work within a one year period after Date of Substantial Completion. Provide HVAC Installer's warranty letter.
- E. Where warranties beyond Contractor's one (1) year warranty are specified, the additional warranty time shall start on the same date as Contractor's warranty.

PART 2 PRODUCTS

2.1 MECHANICAL SLEEVE SEALS

- A. Manufacturers: Link-Seal series model 'C' as manufactured by Thunderline Corporation, Metraseal by Metraflex or Advance Products and Systems Innerlynx.
- B. Synthetic rubber elements linked together to form a watertight seal between pipe and opening for penetrations.
- C. Openings in new construction shall be provided with schedule 40 pipe sleeves having 10 gauge leak plate, 4-inch larger than sleeve O.D., welded thereto and poured in place.

2.2 MANUFACTURED CURBS, EQUIPMENT RAILS and OTHER ROOF ASSEMBLIES

- A. Manufactured Curbs:

1. AES Manufacturing Inc.: www.aescurb.com.
 2. Creative Metals .
 3. Curbs Plus Inc. CPPC-*: www.curbs-plus.com.
 4. Louvers and Dampers.: www.aescurb.com.
 5. The Pate CompanyPC-*: www.patecurbs.com.
 6. RPS AccessoriesRC-*: www.rpscurb.com.
 7. Shipman..
 8. ThyCurb TC-*: www.thybar.com.
- B. Manufactured Equipment Rails:
1. AES Manufacturing Inc.: www.aescurb.com.
 2. Creative Metals .
 3. Curbs Plus Inc. : www.curbs-plus.com.
 4. Louvers and Dampers.SES-O-RC.
 5. The Pate CompanyES-*: www.patecurbs.com.
 6. RPS AccessoriesER-*: www.rpscurb.com.
 7. Shipman.REB.
 8. ThyCurb TEMS-*: www.thybar.com.
- C. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies: Factory-assembled hollow sheet metal construction with fully mitered and welded corners, integral counterflashing, internal reinforcing, and top side and edges formed to shed water.
1. Sheet Metal: Hot-dip zinc coated steel sheet complying with ASTM A 653/A 653M, SS Grade 33 ; G60 coating designation; 18 gage, 0.048 inch thick.
 2. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing insulation; 1:1 slope; minimum cant height 3 inches.
 3. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not on insulation; match slope and configuration of roof deck.
 4. Provide the layouts and configurations shown on the drawings.
- D. Curbs Adjacent to Roof Openings: Provide curb on all sides of opening, with top of curb horizontal for equipment mounting.
1. Provide preservative treated wood nailers along top of curb.
 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 3. Height Above Finished Roof Surface: 8 inches, minimum.
 4. Height Above Roof Deck: 14 inches, minimum.
- E. Equipment Rails: Two-sided curbs in straight lengths, with top of rail horizontal for equipment mounting.
1. Provide preservative treated wood nailers along top of rails.
 2. Height Above Finished Roof Surface: 8 inches, minimum.
 3. Height Above Roof Deck: 14 inches, minimum.
- F. Pipe, Duct, and Conduit Mounting Pedestals: Vertical posts, minimum 8 inches square unless otherwise indicated.
1. Height Above Finished Roof Surface: 8 inches, minimum.
 2. Height Above Roof Deck: 14 inches, minimum.

2.3 PREFABRICATED PIPE CURB:

- A. Manufacturers: Pate: ThyCurb; RPS Corporation.
- B. 18 gauge welded galvanized roof curb with welded sealed corners, insulation, integral 3-inch x 3-inch cant and treated wood nailer.
- C. Curb shall be raised cant, sized and designed for equipment support as shown with minimum 12-inch height, and top 8-inches above top of roof fill.
- D. Weather resistant, UV protected thermoplastic curb cap with step boots for the number of pipes and conduits required.
- E. Neoprene boots with stainless steel pipe clamps securing pipe/conduit to cap.

2.4 NON-PENETRATING ROOFTOP PIPE SUPPORTS

- A. Non-Penetrating Rooftop Supports: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
 - 1. Design Loadings and Configurations: As required by applicable codes.
 - 2. Height: Provide minimum clearance of 5 inches under supported items to top of roofing.
 - 3. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
- B. Pipe Supports for Refrigerant Piping and Condensate Drain Piping:
 - 1. Manufacturers: PHP-SS8-C; Cooper B-Line Dura-Blok; MIFAB - C-Port
 - 2. Base support assembly shall be recycled rubber or polypropylene with UV-inhibitors, and a 14 gauge steel roll-formed 3-sided channel with galvanized finish to support piping.
 - 3. Hardware, Clamps, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.
 - 4. Secure all piping to base with channel clamps. Insulation shall be installed continuous through pipe clamps at each support location.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Hazardous Materials:
 - 1. Design Professional's Responsibility: Plans and specifications have been prepared by the A/E for Owner without the Design Professional having conducted investigation as to the presence of asbestos or hazardous waste on the project. Not being a part of this contract, the Design Professional has not charged any fees and has not and will not advise Owner with regard to the detection and/or removal of asbestos or hazardous waste. Owner is aware that asbestos or hazardous waste could be present and will make all decisions with regard to its removal. The removal of all hazardous materials and encapsulation of remaining surfaces is the sole responsibility of Owner.

2. If Contractor observes the existence of a friable material which must be disturbed during the course of his work, Contractor shall promptly notify Owner and Architect. Owner shall make all arrangements regarding testing and removal or encapsulation of asbestos material if present. Contractor shall not perform any work pertinent to the friable material prior to receipt of special instructions from Owner through Architect.
 3. "Friable Material" is any material which can be crumbled, pulverized or reduced to a powder by hand pressure when dry.
- B. Refer to the specifications and Architectural and Structural drawings for additional requirements pertaining to work under this discipline. Notify Architect for clarification in the event of conflict.
- C. All materials of systems installation exposed in hollow spaces that are used as ducts or plenums shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less.

3.2 PREPARATION

- A. Drawings are diagrammatic and show the general proximity of the equipment, ducts, and pipes, etc., are not to be scaled, and do not include all required changes in direction or offsets necessary in coordinating the installation of various materials either between trades or within the same trade. All dimensions shall be verified at the building site. Prefabrication and/or installation of work from drawings shall be at Contractor's risk. Refer to Architectural plans for exact building dimensions and details.
- B. Space Conditions:
1. All apparatus shall fit into the available spaces in the building and must be introduced into the building so as not to cause damage to the structure. Equipment larger than access to equipment spaces shall be disassembled into sub-assemblies for installation.
 2. Where deviations from the plans are required in order to conform to the space limitations, such changes shall be made at no additional cost to Owner and shall be subject to approval.
 3. All equipment requiring service shall be made accessible. Coordinate piping and ductwork installation to avoid conflict with other trades.

3.3 HVAC DEMOLITION

- A. The project demolition plans have been prepared to assist Contractor in determining the scope of demolition work and should not be construed to be all of the demolition required. Contractor shall visit job site (after carefully reviewing the contract documents) and determine exact areas and quantities of existing materials to be removed to accomplish new construction.
- B. In general, all existing material removed from the facility shall be the property of Contractor, unless otherwise noted, and shall be removed from the facility as required by the Contract provisions concerning trash removal.

- C. Existing water-source heatpumps which are removed and are not re-used in the new work shall be turned over to Owner's representative as directed.
- D. Material and equipment which has been removed shall not be used in the new work, except as noted.
- E. Where the Documents indicate an equipment item to be removed. Remove all associated material including hangers, supports, wiring, controls conduit, etc. Do not leave abandoned items.
- F. Dispose of any material to be discarded in accordance with all laws and regulations.
- G. Existing Refrigerant: Properly remove the existing refrigerant and store in approved containers and store, turn over to Owner's representative, or salvage as required before removing any refrigeration equipment related to this Project.

3.4 EXISTING HVAC SYSTEMS

- A. The existing mechanical equipment and systems shall remain "as-is" except as otherwise indicated or specified. Perform all work necessary to properly tie in new work with existing conditions and to adapt existing conditions to conform to the changes in the building and systems.
- B. Remove exposed and accessible piping, ductwork, and other materials rendered useless due to changes or modifications. Cap outlets in piping. Blank-off or patch openings in ductwork and duct insulation. Repair insulation damaged during construction.
- C. Remove concealed piping which is exposed by the removal of walls, partitions, etc., and reconnect and re-route as required to maintain system continuity.
- D. Sleeves left open by removal of piping shall be cut flush with the finished slab or wall, filled with non-shrinking cement grout and/or fire rated foam flush with both sides of slab or wall to maintain slab or wall fire rating and finished to match the space finishes.
- E. Openings left by removal of ductwork shall be patched matching existing construction.
- F. Where existing piping, duct and/or equipment is shown on the Drawings to be reused, its identity, size, flow direction and location shall be verified prior to performing any work. Notify Architect of any discrepancies.

3.5 EXISTING HVAC EQUIPMENT -

- A. This project makes use of existing HVAC equipment located in/at Building 100.
- B. The documents specify modifications to some of the existing equipment to be used in the modified system.
- C. The documents specify the testing of this equipment and recording the condition of the equipment as part of the retro-commissioning work.

- D. The documents specify checking and documenting the control interlocks for the existing equipment and systems to be reused as part of the retro-commissioning work.
- E. Include these activities in the overall construction schedule. Ensure that the schedule leaves time for any deficiencies to be identified and corrected before occupancy.

3.6 INSTALLATION

- A. Indoor Air Quality Environment: The Construction Manager shall schedule work and provide temporary ventilation and/or isolation to ensure that fumes from welding, other construction tasks, and out-gassing from construction materials do not migrate to adjacent occupied areas.
- B. Clearance above and in front of electrical switchgear, electrical power panels or control panels shall be maintained by mechanical systems so that no mechanical ducts, pipes, vents or equipment is routed above or across the space directly above this equipment in conformance with the National Electrical Code.
- C. All equipment shall be installed in accordance with manufacturers' published installation instructions shipped with the equipment. In the event there is a discrepancy between these specifications or Drawings and the manufacturers' instructions, no work shall be performed until additional instructions are received.
- D. Install and connect all appliances, equipment, and appurtenances as specified, indicated or required in accordance with the manufacturer's instructions and recommendations. Furnish and install complete auxiliary piping, water seals, valves, electric connections, and similar items, recommended by the manufacturer or as required for proper operation.
- E. Equipment, valves and other items installed under this division requiring service shall be installed to be readily accessible. Refer to definitions in this section.
- F. Coordinate with Contractor and monitor the progress of the work so that other trades do not obstruct items requiring access for service.
- G. After final balancing, equipment with belt drives shall have their belts operating in the mid-80% position of the adjustable sheave.
- H. Provide equipment belt and coupling guards shielding the perimeter and face of all new belt drives, shafts and couplings. Provide openings opposite drive and driven shafts to permit use of revolution counter. Guards for fans shall be supported from the fan and mounting base, independent of the floor or housekeeping pad.
- I. Route piping and ductwork to avoid skylights, translucent, and transparent ceilings.
- J. Pipe Sleeves in Slabs, Masonry Walls and Partitions:
 - 1. Provide sleeves in all slabs and walls/partitions unless otherwise noted.
 - 2. Omit sleeves on cast iron pipe through slabs on grade.
 - 3. Provide sleeve seals where pipe passes thru building wall to a below grade location.
 - 4. Elevated Slabs: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in

- the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a slab.
5. Masonry Partitions: Twenty gage galvanized steel: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated masonry wall/partition.
 6. Omit sleeves in openings core drilled in masonry partitions.
 7. Rated Drywall Partitions: Twenty gage galvanized steel. Sleeves shall be sized to include the insulation with minimum gap around the insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated drywall wall/partition.
 8. Non-Rated Drywall Partitions: Omit sleeves.
- K. Pipe sleeves in footings and foundation walls:
1. Schedule 40 black steel pipe.
 2. Cooling tower and condenser water piping passing under a footing or through a foundation wall shall be installed in a pipe sleeve, two pipe sizes larger than the pipe passing through.
 3. Sleeves in walls to spaces below grade shall be provided with 10 gauge leak plates.
- L. Seal sleeves and openings in mechanical room walls, fire rated partitions, and floors above grade vaportight, watertight, or for smoke/fire protection as applicable. Refer to Section 07 8400 .
- M. Seal sleeves and openings in exterior walls vaportight or watertight as applicable. Refer to Section 07 9000.
- N. Provide sleeve seals at all exterior pipe penetrations, above and below grade. Comply with manufacturer's sizing recommendations for size of pipes penetrating wall.
- O. Install roof equipment support rails spanning roof joists.
- P. Equipment and pipe support upper attachments shall be 3" x 3" x 1/4" steel angles, minimum, spanning structural members unless noted otherwise. Provide inserts and bolts for supporting pipes and equipment from structural members.
- Q. Saw cut or core drill openings in existing work for the installation of the mechanical system. Patching shall be performed by the trade whose work is cut. Contractor shall lay out and install his work ahead of the work of other trades wherever possible.
- R. Continuity of Building Services:
1. Conform to staging as described under Division 01.
 2. Sequence equipment installation and schedule work to ensure that systems of existing building(s) is(are) not interrupted when they are required for normal usage of the existing building(s).
 3. Perform work to provide minimum inconvenience to Owner and as approved by Architect. No allowance will be made for lack of knowledge of existing conditions.

3.7 SPACE CONDITIONING DURING CONSTRUCTION

- A. Coordinate with Contractor regarding the limits of space conditions specified or requested by other trade sections.
- B. Assist Contractor in the preparation of the construction schedule and determine to what extent the building HVAC system can be operated within the restrictions listed below to help maintain those conditions.
- C. Ducted air handling systems shall not be placed into operation for testing or for temporary space conditioning until all walls in areas served by the system have been prepared for painting and the building is broom clean.
- D. The building's HVAC system shall be kept clean during the entire construction process. Protect equipment, motor, ducts, pipes from dirt and debris.
- E. Filters during construction:
 - 1. Provide and maintain filters on all air handling equipment and terminal units used for space conditioning during construction.
 - 2. Provide and maintain filters on all return air grilles once ceilings are installed when air handling equipment or terminal units are used for space conditioning during construction.
 - 3. Provide filters with a minimum MERV rating of 8.
- F. Heating Terminal units such as unit heaters or cabinet heaters may be used for temporary heat during construction. Clean to new condition.

3.8 PIPING PRESSURE TESTS

- A. General:
 - 1. Provide 48 hours notification to Architect in advance of any test.
 - 2. Complete tests prior to insulating. Leaks shall be repaired, defective materials replaced, and system shall be retested. Strike all joints in copper and steel piping under a pressure test. Conduct tests prior to connecting to equipment or isolate equipment from system.
 - 3. No water pressure test shall be conducted in freezing weather where subject to freezing.
 - 4. Test shall be maintained at conditions specified until approved but, in no event, for less than eight (8) hours minimum duration, unless otherwise noted.
 - 5. Hydrostatic pressure tests shall maintain pressure without change, except that due to temperature change.
- B. Refrigerant Piping: Refer to Section 23 2300.
- C. Cooling Tower Water Piping: Hydrostatic test; 150 PSIG.
- D. Heat Pump Condenser Water Piping: Hydrostatic test; 150 PSIG.

3.9 EQUIPMENT BASES and HOUSEKEEPING PADS

- A. Provide housekeeping and equipment bases as shown or listed below. Rough up slab under bases before pouring concrete.
- B. Materials: Refer to Section 03 3000 - Cast-in-Place Concrete. Omit test cylinders for concrete poured under this section.
- C. Bases/Pads shall be rectangular with vertical sides 4-inches from centerline of anchor bolts or 2 inches from edges of equipment supports, whichever provides the larger dimension, side of equipment or base edge, unless otherwise noted.
- D. Height:
 - 1. HVAC Pumps: 8-inches.
 - 2. Boilers: 4-inches.
 - 3. Tanks: 4-inches
 - 4. Heat Exchangers: 4 inches
 - 5. Air Handling Units: 4 inches, minimum, unless noted otherwise on Drawings. Increase pad height for unit furnished to provide space for condensate drain trap, refer to trap detail on drawings.
 - 6. Housekeeping Pads for Other Equipment: 4-inches or as shown on plans.
 - 7. Condensing Unit (7 Tons and Smaller - Grade): Concrete pad, refer to detail.
 - 8. Condensing Units (7 Tons and Smaller - Roof): Roof equipment rails.
- E. Chamfer: 3/4-inch on edges and corners.
- F. Reinforcing: #3 bars 12 inches on center each way. (Base/Pad over 6 inch thickness.)
- G. Reinforcing: 6"x 6" 10/10 WWF at mid-depth of slab. (4 inch thick pads.)

3.10 EQUIPMENT BACKBOARDS

- A. General: Provide wood backboards for installation of surface mounted control panels, enclosed motor controllers, variable frequency controllers, and where shown.
- B. Type: 3/4-inch thick grade 1 fire retardant treated plywood supported by 3/4" x 3/4" x 1/8" aluminum angle frame attached to wall with 1/4-inch toggle bolts for hollow masonry, expansion shields for solid masonry.
- C. Finish: Frame and board with two coats light gray enamel paint.

3.11 COMMISSIONING

- A. The project Commissioning Authority (CxA) will manage the commissioning process for select equipment and systems. The commissioning process will begin during the design phase and continue through the first year warranty period. The commissioning process shall encompass and coordinate the functions of system documentation, equipment startup, control system calibration, test adjust and balance, performance testing and training. The intent of commissioning is to verify and document that applicable equipment and systems are installed according to the manufacturer's recommendations and to

industry accepted minimum standards and that they receive adequate operational checkout by the installing contractors; verify and document proper functional performance of equipment and systems; verify that O&M documentation submitted is complete and accurate; verify that the Owner's operations personnel are adequately trained.

- B. Commissioning Tests: Provide assistance to the Commissioning Authority for scheduling and witnessing of testing. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.12 STARTING EQUIPMENT AND SYSTEMS

- A. Start no equipment or systems until all Prefunctional checklist forms for all equipment installed under Div. 23 have been completed, signed, and sent to the Construction Manager for approval, and prior to start of any TAB fieldwork for that equipment. Provide copies of the factory service technician start-up reports.
- B. Adjust equipment for proper operation within manufacturers' published tolerances.
- C. Demonstrate proper operation of systems and equipment to Owner 's designated representative.

3.13 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. Frame sequence of operation under glass and mount on a wall in mechanical room.
- B. Instruct operating personnel designated by the Owner in operation and maintenance of system prior to request for final inspection. Provide signed statement certifying instructions have been received.
- C. A manufacturer's service representative shall provide the instructions for each piece of equipment on system when specified in other Sections of this Division. A manufacturer's sales representative is not acceptable. (The instructor shall not be a sales person, but shall have service experience on a continuing basis and be knowledgeable about the subject equipment.)
- D. The Contractor shall give notice to Architect not less than 45 days of the anticipated date of instruction to allow planning by the Owner.
- E. The Contractor shall request the instruction date not less than 15 days of the desired date for coordination with the Owner. Operating manuals for the equipment/systems on which instructions are being given shall be in the possession of the operating personnel not less than 30 days prior to the date of instruction.
- F. The contractor shall give an orientation session to operating personnel for achieving familiarity (not instructions) of the systems approximately 5 days prior to the instruction date. The Contractor's representative giving instruction shall be knowledgeable in the equipment/systems to allow quality recordings by the Owner.
- G. The Contractor shall develop not less than three (3) copies of the instructions with an index for easy retrieval of information.

- H. Equipment and Systems Included in the Training Plan:
1. Fire, Smoke, and Combination Fire/Smoke Dampers
 2. Variable Speed Drives
 3. Cooling Towers
 4. Boilers
 5. Pumps
 6. Heat Exchangers
 7. DOAS - Air Handling Units
 8. Water Source Heat Pump Units
 9. Split System Air Conditioning Units
 10. DOAS - Air Handling Units with Energy Recovery
 11. Power Ventilators
 12. Lab Exhaust Systems
 13. Terminal Heating Units
 14. HVAC Instrumentation & Direct Digital Control System

3.14 CLEANING and PROTECTION

- A. All materials, equipment and mechanical rooms shall be cleaned prior to Substantial Completion.
- B. Wash down and scrub clean all mechanical room floors, walls, equipment bases and equipment.
- C. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish.
- D. All air handling equipment shall be cleaned internally prior to Substantial Completion. Clean unit casing externally and internally. Seal/replace all damaged duct liner.
- E. Chipped or scraped paint shall be retouched to match original finish.
- F. Clean and polish all equipment nameplates. All nameplate information shall be legible.
- G. All dents and sags in ductwork and equipment casings shall be straightened.
- H. All ductwork, insulation, equipment, pipe, pipe fittings and appurtenances shall be free of dust, rust and stains prior to Substantial Completion.

3.15 FINISHING EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint shop-primed equipment.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

- E. Paint exposed bare steel piping in accordance with ANSI 13.1 Standard for the following color schedule:
 - 1. Cooling Tower Water Piping: Green
 - 2. Heat Pump Water Piping: Green
 - 3. Safety Vent Piping: Yellow
 - 4. Blowdown and Equipment Drain Piping: Yellow
- F. Paint all piping and equipment hangers, brackets, collars and supports, unless otherwise indicated.
- G. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish shall be painted to prevent rust.
- H. Paint all exposed un-insulated ferrous metals, flat black.
- I. Paint miscellaneous ferrous metals such as nipples and fittings on condenser water piping at drains, vents and instrument tappings before insulation.
- J. Paint all exterior un-insulated ferrous metals at cooling tower and tower piping with aluminum paint.
- K. Paint interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
- L. Paint dampers exposed behind louvers, grilles to match face panels.

END OF SECTION 23 0510

SECTION 23 0513 - MOTORS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 RELATED REQUIREMENTS

- A. Section 0515 - Enclosed Motor Controllers.
- B. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.
- C. NEMA MG 1 - Motors and Generators; 2014.
- D. NFPA 70 - National Electrical Code, , 2017 Edition.

1.4 SUBMITTALS

- A. See Section 23 0510 - General Mechanical Requirements, for submittal procedures.
- B. Product Data:
 - 1. Provide wiring diagrams with electrical characteristics and connection requirements.
 - 2. Provide product data including motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, motor type, enclosure type, insulation class, NEMA design designation, service factor, power factor at full load, nominal efficiency at full load and weight.
- C. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.

- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.
- G. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.5 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Baldor, Century, Lincoln, Marathon, Toshiba.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service:
 - 1. Motors 1/3 Hp and smaller: 115 volts, single phase, 60 Hz.
 - 2. Motors 1/2/ HP and larger: three phase 60 Hz.
 - a. 200 volt motors on 208 volt systems.
 - b. 460 volt motors on 480 volt systems.
 - 3. Refer to Electrical drawings for voltage and phase required.
- B. Overload Protection: Single phase motors shall be furnished with built-in automatic reset overload protection.
- C. Efficiency: Motors 1 HP and larger shall be premium efficiency motors and have minimum full load efficiencies not less than listed in the Energy Code.
- D. Brake Horsepower: All motors shall have rated horsepower at least 10 percent above the indicated brake horsepower of equipment including belt losses and inlet vane losses.
- E. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

4. All copper windings and leads.
 5. Motors for belt driven equipment and base mounted pumps shall have cast iron yoke and bearing housings.
- F. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- G. Motors serviced by Variable Frequency Controllers:
1. Motors shall be Definite Purpose Inverter-Fed Motors complying with NEMA MG1-Part 31. Stator laminations shall be vacuum-pressure impregnated with varnish for reduction of audible motor noise.
 2. Motors shall be equipped with factory installed grounding rings to electrically ground the motor shaft to prevent eddy current damage to bearings, AEGIS-SCR.
- H. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.
- B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- C. Single phase motors for fans: Capacitor start, capacitor run type.
- D. Motors located in outdoors and in draw through cooling towers: Totally enclosed weatherproof epoxy-treated type.

2.4 SINGLE PHASE POWER - ELECTRONIC COMMUTATED MOTORS

- A. Motor to be an electronic commutation (EC) motor specifically designed for fan applications.
- B. Permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor.
- C. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.5 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.6 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.7 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

- H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- I. Sound Power Levels: To NEMA MG 1.
- J. Weatherproof Epoxy Sealed Motors: Epoxy coat windings with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- K. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 23 0513

SECTION 23 0514 - VARIABLE FREQUENCY CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable frequency controllers

1.2 RELATED SECTIONS

- A. Section 23 0513 - Motors for HVAC Equipment.
- B. Section 23 0553 - Identification HVAC Piping and Equipment.
- C. Section 23 0994 - HVAC Sequence of Operation.
- D. Section 23 0800 - Commissioning of HVAC System.
- E. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems; 2006.
- B. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives; National Electrical Manufacturers Association, 2006.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum), National Electrical Manufacturers Association, 2008.
- D. IEEE 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems; Institute of Electrical and Electronic Engineers; 1992 (R2004).
- E. NFPA 70 - National Electrical Code 2014 Edition.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Provide programming manual for drive.

- D. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- E. Rating: Submittal shall specifically indicate that drive size submitted is rated for horsepower being served with drive at 40 degrees C (104 degrees F) and minimum of 4,000 hz switching frequency. Drives rated at lower frequencies are not acceptable.
- F. Test Reports: Indicate field test and inspection procedures and test results.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- H. Manufacturer's Field Reports: Indicate start-up inspection findings.
- I. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- J. Maintenance Data: NEMA ICS 7.1. Include routine preventive maintenance schedule.
- K. Unit Setup Data: Provide all setup procedures, setup parameters, and final settings for each Variable Frequency Controller installed in the project.
- L. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- M. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide a three year warranty for all variable speed drive components to include materials only.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB ACH550, Cutler Hammer SV9000, Danfoss VLT 6000, Toshiba E3 Series, Yaskawa E7.

2.2 DESCRIPTION

- A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
 - 1. Employ microprocessor-based inverter logic isolated from power circuits.
 - 2. Employ pulse-width-modulated inverter system providing a carrier frequency adjustable from 4,000Hz to 8,000Hz.
 - 3. Design for ability to operate controller with motor disconnected from output.
 - 4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.
- B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places accessible only to qualified personnel.
- C. Finish: Manufacturer's standard enamel.

2.3 OPERATING REQUIREMENTS

- A. Rated Input Voltage: 480 volts, three phase, 60 Hertz.
- B. Motor Nameplate Voltage: 460 volts, three phase, 60 Hertz.
- C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- D. Operating Ambient: 0 degrees C to 40 degrees C.
- E. Minimum Efficiency at Full Load: 95 percent.
- F. Volts Per Hertz Adjustment: Plus or minus 10 percent.
- G. Current Limit Adjustment: 60 to 110 percent of rated.
- H. Acceleration Rate Adjustment: .5 to 360 seconds.

- I. Deceleration Rate Adjustment: 1 to 360 seconds.
- J. Input Signal: 4 to 20 mA DC.

2.4 COMPONENTS

- A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
- B. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
- C. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
- D. Include undervoltage release.
- E. Control Power Source: Integral control transformer.
- F. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
- G. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
- H. Control Interlocks:
 - 1. Furnish terminals for remote contact to allow starting in automatic mode.
 - 2. The unit controller shall support operation on a BACnet network via a factory-installed communication module for interface with the BAS.
 - 3. The information communicated between the BAS and the unit controller shall allow unit monitoring, control and alarm notification. Provide auxiliary outputs to comply with the sequence of operation and the BAS I/O points list. Furnish programmable analog outputs(two minimum) and programmable digital outputs(three minimum).
- I. Manual Bypass: Bypass shall be integral to the variable speed drive and manufactured by same firm that manufactures drive. Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. By-pass shall be two contactor type (does not allow maintenance on inverter while motor is operating).
- J. Emergency Stop: Use dynamic brakes for emergency stop function.
- K. Jogging: On drives serving motors of supply, return, or exhaust fans ducted into one single header duct, provide capability to bring motor up to preset, adjustable, low speed, prior to fan isolation damper opening, signal fan isolation damper to open, then continue to ramp motor up to controlled speed.
- L. Disconnecting Means: Include integral circuit breaker on the line side of each controller.
- M. Wiring Terminations: Match conductor materials and sizes indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surface is suitable for controller installation.
- B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.2 INSTALLATION

- A. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
- B. Tighten accessible connections and mechanical fasteners after placing controller.
- C. Variable frequency controllers shall not be installed within the air stream of an air handling unit or outside air energy recovery unit.
- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Provide engraved plastic nameplates; refer to Section 23 0553 - Mechanical Identification, for product requirements and location.
- F. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide services of factory trained representative to prepare and start the controllers, calibrate the controls and inspect the installation.
- B. Provide services of factory trained representative to instruct Owner on operation and maintenance.
- C. Provide start-up certificate in the format prescribed by the General Conditions.

3.4 ADJUSTING

- A. Make final adjustments to installed controller to assure proper operation of load system. Obtain performance requirements from installer of driven loads.

3.5 COMMISSIONING TESTS

- A. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.

- B. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.6 SCHEDULE

- A. Provide variable frequency controllers for HVAC equipment where specified or indicated on the drawings.

END OF SECTION 23 0514

SECTION 23 0515 - ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Magnetic motor controllers
- B. Combination magnetic motor controllers and disconnects

1.2 RELATED SECTIONS

- A. Section 23 0553 - Mechanical Identification: Engraved nameplates
- B. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. NECA (INST) - Standard of Installation; National Electrical Contractors Association; 1993.
- B. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches; 1993.
- C. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 1993.
- D. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; National Electrical Manufacturers Association; 1993(Rev 1,1996).
- E. NEMA ICS 6 - Industrial Control and Systems: Enclosures; National Electrical Manufacturers Association; 1993.
- F. NFPA 70 - National Electrical Code 2017 Edition.

1.4 SUBMITTALS

- A. Refer to Section 23 0510- General Mechanical Requirements, for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Maintenance Data: Replacement parts list for controllers.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70, 2011 Edition.
- B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Allen Bradley, Cutler Hammer, Furnas, General Electric, Siemens, Square-D.

2.2 AUTOMATIC CONTROLLERS

- A. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Starters shall be NEMA type starters. IEC type starters are not allowed.
- C. Coil Operating Voltage: 120 volts, 60 Hertz.
- D. Overload Relays: NEMA ICS 2; bimetal.
- E. Enclosures:
 - 1. Enclosures: NEMA ICS 6, Type 1 indoors.
 - 2. Enclosures: NEMA ICS 6, Type 3R outdoors.

2.3 ACCESSORIES

- A. Refer to HVAC Sequence of Operation for auxiliary contacts and where pushbuttons and remote pushbutton stations are required.
- B. Auxiliary Contacts: NEMA ICS 2, 2 field convertible contacts in addition to seal-in contact.
- C. Pilot Device Contacts: NEMA ICS 5, Form Z, rated A150.
- D. Indicating Lights: Transformer, LED type.
- E. Selector Switches: Rotary type Hand-Off-Automatic. Provide unless noted otherwise.
- F. Control Power Transformers: 120 volt secondary, 145 VA minimum, in each motor starter. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

2.4 DISCONNECTS

- A. Combination Controllers: Combine motor controllers with disconnects in common enclosure. Obtain IEC Class 2 coordinated component protection.
- B. Thermal Magnetic Circuit Breakers: NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All three phase motors furnished under this Division not fed from a starter in a motor control center or Variable Frequency Controller shall be provided with combination starter and circuit breaker unless otherwise noted.
- B. Install enclosed controllers where indicated, in accordance with NECA Standard of Installation.
- C. Install enclosed controllers plumb.
- D. Height: 5 ft to operating handle.
- E. Install with minimum of four anchors.
- F. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.
- G. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- H. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- I. Provide engraved plastic nameplates; refer to Section 23 0553 for product requirements and location.
- J. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating, panel and circuit number. Place label in clear plastic holder.

END OF SECTION 23 0515

SECTION 23 0516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.

1.2 RELATED REQUIREMENTS

- A. Section 23 2113 - HYDRONIC PIPING.

1.3 REFERENCE STANDARDS

- A. EJMA (STDS) - EJMA Standards; Tenth Edition.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- C. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- D. Maintenance Data: Include adjustment instructions.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturer: Southeastern Hose Model SEC.
- B. Other acceptable manufacturers offering equivalent products.
 - 1. BOA Model B3-1.
 - 2. Flexible Metal Hose Co. Model DFC.
 - 3. Reflex Model KFCS.
 - 4. Metraflex Model ML.
 - 5. Twin City Model TCHS.
 - 6. Whatley Model SS.
- C. Inner Hose: Stainless Steel.

- D. Exterior Sleeve: Single braided, stainless steel.
- E. Pressure Rating: 125 psi and 450 degrees F.
- F. Joint: Flanged.
- G. Size: Use pipe sized units.
- H. Length:
 - 1. Not less than three pipe diameters.
- I. Maximum offset: 3/4 inch on each side of installed center line.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install flexible pipe connectors on pipes connected to vibration isolated equipment.
Provide line size flexible connectors.
- C. Provide support and equipment required to control expansion and contraction of piping.
Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 23 0516

SECTION 23 0519 - METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Balancing Flow meters.
- B. Pressure gages and pressure gage taps.
- C. Thermometers and thermometer wells.
- D. Test Plugs.

1.2 RELATED REQUIREMENTS

- A. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- B. Section 23 2113 - HYDRONIC PIPING.
- C. Section 23 0923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.

1.4 SUBMITTALS

- A. Refer to Section - General Mechanical Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

1.5 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.1 LIQUID FLOW METERS

- A. Hydronic differential pressure flow meter (venturi type):
1. Manufacturers: Barco/Aeroquip, Velocity Profile, Gerand, and Robertson.
 2. A coordinated system, including individual Venturi Flow Stations and one Portable Master Meter, supplied by one manufacturer.
 3. Venturi Flow Stations:
 - a. Shall be cadmium plated steel butt weld over 8-inches.
 - b. Provide with quick disconnect valves, safety shut-off valves, and metal identification tag on chain, giving pipe size, Venturi series, station identification, and meter reading at specified flow rate..
 - 1) Shall be selected so differential at design flow rate is between 10 and 40 inches W.P. with permanent pressure loss not more than 25% of indicated flow rate differential pressure.
 - c. Shall be rated at plus or minus 5.0% accuracy.
 4. Master Meter:
 - a. Provide in addition to the capability of being monitored by the DDC control system.
 - b. Shall be a 6-inch round, dial, dry type meter with a minimum scale reading 0 to 50 inches of water differential pressure.
 5. Provide in a waterproof carrying case with two 10-foot lengths of 1/4-inch high pressure, high temperature connecting hose, quick disconnect socket valves, venting valves, installation and operating instructions and capacity curves.

2.2 BALANCING FLOW METERS

- A. Annular element flow stations:
1. Manufacturers: Armstrong Verabar, Barco, Mid-West, Preso Ellipse.
 2. Measuring Station: Type 316 stainless steel pitot type flow element inserted through welded threaded couplet, with safety shut-off valves and quick coupling connections, and permanent metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.
 3. Pressure rating: 275 psi.
 4. Maximum temperature: 400 degrees F.
 5. Accuracy: Plus 0.55 percent to minus 2.30 percent.

2.3 PRESSURE GAGES

- A. Manufacturers:
1. Trerice Model 500X.
 2. Other acceptable manufacturers offering equivalent products: Duro 102, Marsh 103, Palmer 40SPDLH, Weksler BM1, Weiss AG-1.

- B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Cast aluminum with phosphor bronze bourdon tube, Stem(flangeless) mounting.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Hydronic Water Scale: Feet-H₂O in 2 ft graduations. Scale range shall be so pump suction pressure is above lower 10% and pump discharge is below upper 10% of scale range.

2.4 PRESSURE GAGE TAPPINGS

- A. Ball Valve: 1/4 inch, 400 psig WOG, Bronze two piece body, standard port, chrome plated brass ball, reinforced teflon seats and stuffing box ring, blow-out proof stem design, adjustable packing gland, zinc coated steel lever handle with vinyl hand grip, threaded ends.
- B. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections, as manufactured by Trerice, Model 872, Duro, Marsh, Weksler, Weiss.

2.5 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Trerice Model AX9.
 - 2. Other acceptable manufacturers offering equivalent products: Ashcroft 200-36E, Duro 7EZ3-6, Moeller 706AW, Palmer 9FLA, Weksler AA5, Weiss A9VU.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E 77.
 - 5. Calibration: Degrees F.

2.6 THERMOMETER SUPPORTS

- A. Socket: Brass or stainless steel separable sockets for thermometer stems. Provide cap and chain where not used to mount permanent instrument or control sensor. Provide lagging extension when mounted on insulated pipe.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.7 TEST PLUGS

- A. Manufacturers:
 - 1. FDI Model Super Seal.
 - 2. Other acceptable manufacturers offering equivalent products: MG Piping Products Co., Sisco, Trerice, Texas Fairfax, Universal Lancaster.
- B. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F. Provide extra-long shaft when mounted on insulated pipe.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install flow meters in pipe lines indicated on Drawings with the manufacturer's required straight length of pipe entering and leaving meter.
- C. Pump Differential Pressure Stations:
 - 1. Provide one pressure gage per base mounted pump, installing taps before strainer (Suction Diffuser) and on suction and discharge of pump.
 - 2. Pipe to pressure gage mounting with copper or brass tubing.
 - 3. Provide a test port at each tap location such that piping is straight through and can be cleared with a rod inserted through the port and the tap. Use a tee fitting to route to the pressure gauge with isolation valves as required to isolate each pressure tap location.
- D. Provide two pressure gages per in-line pump, installing taps on suction and discharge of pump. Pipe to gage with copper or brass tubing.
- E. Install pressure gages on hydronic systems with pulsation dampers. Provide ball valve to isolate each gage connection to system. Extend nipples to allow clearance from insulation.
- F. Differential pressure transducer piping manifold:
 - 1. Tap tubing from side of pipe mains, not top or bottom. Tubing shall be copper or brass.
 - 2. Provide manifold unions across the supply and return mains with isolation valves.
 - 3. Provide a pressure gage across the supply and return mains in parallel with the pressure transducer.
 - 4. Provide test ports across the transducer and a blowdown on each side of the transducer.
 - 5. Install manifold at 5'-0" AFF.
- G. Install pressure tappings on piping where specified or shown on flow diagrams and details. Provide valve to isolate each tapping connection to system. Extend nipples to clear insulation.

- H. Install sockets for all thermometers and control sensors. Provide spare sockets with cap and chain as shown on flow diagrams and details.
- I. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets.
- J. Mount sockets in 3/4 inch NPT pipe openings. Install vertical to 45 degrees off vertical. Use lateral-o-let on vertical pipe.
- K. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- L. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- M. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- N. Locate test plugs adjacent to thermometers, temperature wells, pressure gages, coil connections, and where shown on flow diagrams and details. Install in 1/2 inch pipe opening(minimum), with bushing.
- O. Install test plugs vertical to horizontal. Do not install pointing down.

3.2 SCHEDULE

- A. Balancing Flow Meters, Location:
 - 1. Provide annular balancing flow stations where shown on flow diagrams.
- B. Pressure Gages, Location:
 - 1. Provide pressure gages where shown on flow diagrams and details.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Provide thermometers where shown on flow diagrams and details.
 - 2. Tower Water and Condenser Water, 0 to 160 degrees F in two degree divisions.

END OF SECTION 23 0519

SECTION 23 0533 - HEAT TRACING FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Self-regulating parallel resistance electric heating cable.

1.2 RELATED REQUIREMENTS

- A. Section 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.
- B. Section 23 0719 - HVAC PIPING INSULATION.
- C. Section 23 2113 - HYDRONIC PIPING.
- D. Section 23 2114 - HYDRONIC SPECIALTIES.
- E. Section 26 2717 - Equipment Wiring.

1.3 REFERENCE STANDARDS

- A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications; 2012.
- B. NFPA 70 - National Electrical Code; National Fire Protection Association; 2014.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.
- B. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data for electric heat tracing.
- C. Shop Drawings: Indicate electric heat tracing layout, electrical terminations and controls.
- D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.

- E. Field Quality Control Submittals: Indicate test reports and inspection reports.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, maintenance and repair data, and parts listings.

1.6 QUALITY ASSURANCE

- A. Acceptable Installers: Familiar with the installation of heat-trace cabling and equipment, subject to compliance with requirements of the Contract Documents.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for cables, connection kits, and accessories.

PART 2 PRODUCTS

2.1 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

- A. Manufacturers:
 - 1. Chromalox, Inc; SRL-8: www.chromalox.com/#sle.
 - 2. Pentair: www.pentairthermal.com.
 - 3. Thermon Manufacturing Company: www.thermon.com/#sle.
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL).
- C. Factory Rating and Testing: Comply with IEEE 515.1.
- D. Heating Element:
 - 1. Provide pair of parallel No. 16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.
 - 2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
 - 3. Capable of crossing over itself without overheating.
- E. Insulated Jacket: Flame retardant polyolefin.
- F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.
- G. Maximum Power-On Operating Temperature: 150 degrees F.
- H. Maximum Power-Off Exposure Temperature: 185 degrees F.
- I. Setpoint: 40 degrees F.
- J. Electrical Characteristics:
 - 1. 8 W/lineal ft.
 - 2. 120 volts, single phase, 60 Hz.

2.2 OUTER JACKET MARKINGS

- A. Name of manufacturer, trademark, or other recognized symbol of identification.
- B. Catalog number, reference number, or model.
- C. Month and year of manufacture, date coding, applicable serial number, or equivalent.
- D. Agency listing or approval.

2.3 CONNECTION KITS

- A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.
- B. Furnish with NEMA 4X rating for prevention of corrosion and water ingress.
- C. All components UV stabilized.

2.4 ACCESSORIES

- A. Provide Accessories As Indicated or As Required for Complete Installation, Including but Not Limited To:
 - 1. High temperature, glass filament tape for attachment of heating cable to metal piping.
 - 2. Aluminum self-adhesive tape for attachment of heating cable to plastic piping.
 - 3. Cable ties.
 - 4. Silicone end seals and splice kits.
 - 5. Installation clips.
 - 6. Warning labels for attachment to exterior of piping insulation. Refer to Section 23 0553.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping is ready to receive work.
- B. Verify field measurements are as shown on drawings.
- C. Verify required power is available, in proper location, and ready for use.

3.2 PREPARATION

- A. Clean all surfaces prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install resistance electric heating cable on condenser and tower water pipes exposed outdoors.
- C. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.
- D. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.
- E. Fasten heating cable to pipe with cable ties 12 inch on center. Install with manufacturer's power connectors, splice kits and end seals.
- F. Comply with all national and local code requirements.
- G. Identification:
 - 1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft including cladding over each valve or other equipment that may require maintenance.

3.4 FIELD QUALITY CONTROL

- A. Field Testing and Inspections:
 - 1. Commission system in accordance with installation and operation manual.
 - 2. Inspect for sources of water entry and proper sealing.
 - 3. Inspect weather barrier to confirm that no sharp edges are contacting the trace heating.
 - 4. Minimum Acceptable Insulation Resistance: 20 megohms or greater at a test voltage of 2500 VDC for polymer insulated trace heaters.
 - 5. Test heating cable integrity with megohmmeter at the following intervals:
 - a. Before installing the cable.
 - b. After cable has been installed onto the piping.
 - c. After installing the connection kits.
 - d. After the installation of thermal insulation onto the piping.
 - 6. Measure voltage and current at each unit.
 - 7. Submit written test report showing values measured on each test for each cable.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate operation of heating cable controls.

3.6 PROTECTION

- A. Protect installed products from damage until completion of project.

3.7 SCHEDULE

- A. Install freeze protection heating cable on TOWER WATER pipes exposed outdoors at cooling towers.
 - 1. Tower water supply and return.
 - 2. Condenser water supply and return.

END OF SECTION 23 0533

SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Equipment support bases.
- B. Vibration isolators.
- C. Inertia bases.

1.2 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

- A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; 2015.
- B. Section 23 0510 - General Mechanical Requirements - Equipment Base and Housekeeping Pads.

1.4 SUMMARY:

- A. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, set up, and testing of the Vibration and Motion Control work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, working systems.
- B. Provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of the Work of this Section. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction.
- C. Provide including, but not limited to:
 - 1. Isolation of mechanical equipment including but not limited to fans, air handling units, including bases.
 - 2. Isolation for ductwork and all piping connected to vibration isolated equipment.
 - 3. Supervision and inspection of installation of vibration isolation to equipment.
 - 4. See contents of this Section for specific specifications and schedules of vibration isolators, frames and static deflections.

1.5 SUBMITTALS

- A. Descriptive Data - Submit the Following:
1. An itemized list showing the items of equipment, piping, etc., to be vibration isolated, the vibration isolator type and model number selected, isolator loading and deflection, coil diameter and number of coils in springs, and references to specific shop drawings showing frame construction where specified.
 2. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications and schedules herein. Include load versus deflection curves.
 3. Written approval of the frame design to be used, obtained from the equipment manufacturer.
 4. Written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices, including hangers and bases; alternatively the equipment may be installed by the vibration isolation manufacturer.
 5. An itemized list of all items of equipment to be fitted with flexible duct connections.
 - a. Flexible duct submittals shall contain all information to demonstrate conformance and suitability for the equipment operating conditions including but not limited to pressure, temperature, capacity, mounting, maintenance, etc.
- B. Shop Drawings:
1. Provide schedule of vibration isolator type with location and load on each.
 2. Fully dimensioned fabrication drawings and installation details for vibration isolation bases, member sizes, attachments to isolators, and supported equipment.
 3. Include auxiliary motor slide bases and rails, base weights, inertia bases, concrete weights, equipment static loads, support points, vibration isolators, and detailed layout of isolator location and orientation with static and dynamic load on each isolator.
 4. Include selections from prescriptive design tables that indicate compliance with the applicable building code and the vibration isolator manufacturer's requirements.
 5. Clearly indicate the load and capacity assumptions selected. Include copies of any calculations.
- C. See Section 23 0510 - General Mechanical Requirements for submittal procedures.
- D. Product Data: Provide schedule of vibration isolator type with location and load on each.
- E. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.6 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Product Suppliers: All vibration isolation devices, equipment bases and frames for equipment and piping furnished under all Division 23 Sections shall be designed and furnished by no more than two different isolator manufacturers and no single vibrating element shall be isolated by the products of more than one isolator manufacturer.

- C. Supervision: The installation of all vibration isolation units, and associated hangers and bases shall be under the direct supervision of the vibration isolation manufacturer's representative.
- D. Verification: Examine related Work and surfaces before starting Work of this Section. Report to the Construction Manager, in timely manner in writing, conditions which will prevent proper provision of this Work. Beginning the Work of this Section without reporting unsuitable conditions to the Construction Manager constitutes acceptance of such conditions by Contractor. Perform any required removal, repair, or replacement of this Work caused by unsuitable conditions at no additional cost to the Owner.
- E. Coordination: Comply with Division 1. Coordinate with Finish Systems, Piping Systems and Equipment, Heating, Ventilating and Air Conditioning and Electrical sections for installation of Vibration Isolation. Coordinate with Concrete trade for equipment inertia bases. Coordinate Work of this Section with all other Work.
- F. Perform design and installation in accordance with applicable codes.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Amber Booth: www.amberbooth.com.
- B. Kinetics Noise Control, Inc: www.kineticsnoise.com.
- C. Korfund Dynamics: www.thevmcgroup.com.
- D. Mason Industries: www.mason-ind.com.
- E. Vibration Eliminator Company, Inc: www.veco-ny.com/#sle.
- F. Vibration Eliminator Co.: www.veco-ny.com.
- G. Vibration Mounting and Control: www.vmc-kdc.com.
- H. Vibro-Acoustics: <http://www.vibro-acoustics.com>.

2.2 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
 - 2. Steel springs to function without undue stress or overloading.
 - 3. All equipment mounted on vibration isolated bases to have minimum operating clearance of 2 inches between the base and floor or support beneath unless noted otherwise.

2.3 VIBRATION ISOLATORS

A. Non-Seismic Type:

1. Open Spring Isolators:
 - a. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - b. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - c. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
2. Restrained Closed Spring Isolators:
 - a. Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 - b. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - c. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
 - d. For Exterior Areas: Hot dipped galvanized housings and neoprene coated springs.
3. Spring Hangers:
 - a. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
 - b. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 - c. Misalignment: Capable of 20 degree hanger rod misalignment.
4. Neoprene Rubber Mount or Hanger: Molded rubber designed for 0.4 inch deflection with threaded insert.
5. Neoprene Pad Isolators:
 - a. Rubber or neoprene waffle pads.
 - 1) Hardness: 30 durometer.
 - 2) Thickness: Minimum 1/2 inch.
 - 3) Maximum Loading: 50 psi.
 - 4) Rib Height: Maximum 0.7 times width.
 - b. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

2.4 ROOF CURB ISOLATION BASES

A. Manufacturers.

1. Amber Booth; Model RTIR.
2. Mason Industries; Model CMAB.
3. Kinetics; Model KSR.
4. Vibration Eliminator Co.; Model AR.
5. Vibration Mounting & Control; Model AXR.

- B. Construction: Weather-proof extruded aluminum roof curb rail assembly with spring isolators, EPDM flexible connection and weather seals at bottom and top rails, to support rooftop units.
- C. Design: Curb sized to fit rooftop units supplied and with isolators selected to comply with deflection requirements scheduled. Curb shall be sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Roof curb isolation bases:
 - 1. Set bases for one inch clearance between roof curb and unit.
 - 2. Adjust rooftop unit to be level.
- C. Bases:
 - 1. All bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment, isolators and restraints.
 - 2. Isolators shall be installed after all equipment is installed without changing equipment elevations.
 - 3. Adjust equipment level.
 - 4. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolators or the isolation system.
- D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- E. Vibration isolation hangers shall be positioned as close as possible to the structure without coming in contact with any object (including the structure).
 - 1. Hanger rods shall not contact any object which would short circuit the isolator.
- F. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for scheduled distance.
 - 1. Up to 4 Inches Pipe Size: First three points of support.
 - 2. 5 to 8 Inches Pipe Size: First four points of support.

3.2 SCHEDULE

- A. Equipment Isolation Schedule.
 - 1. Select isolation devices for uniform static deflection according to distribution of weight of the Equipment isolated.
 - 2. HVAC Pumps on Grade.
 - a. Base: 8 inch concrete pad.
 - 3. Roof Mounted Fume Exhaust Fans.
 - a. Base: Roof Mounted Support Rails.

- b. Isolator Type: Restrained Closed Spring Isolators
 - c. Isolator Deflection: 0.75 inches.
- 4. Suspended fans:
 - a. Isolator Type: Rubber Mount or Hanger.
- 5. Water Source Heat Pumps:
 - a. Isolator Type: Rubber Mount or Hanger.
- 6. Air Cooled Condensing Units (Roof Mounted).
 - a. Base: Roof Mounted Support Rails.
 - b. Isolator Type: Neoprene Pads.
 - c. Isolator Deflection: 0.25 inches.
- 7. Packaged Dedicated Outside Air System Units.
 - a. Base Type: Roof curb isolation base.
 - b. Isolator Type: spring.
 - c. Isolator Deflection: 1.0 inches.
- 8. Cooling Tower (Circuit Cooler).
 - a. Base Type: 8 - inch concrete pad.
 - b. Isolator Type: Neoprene Pads.
 - c. Isolator Deflection: 0.25 inches.

END OF SECTION 23 0548

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe Markers.
- D. Valve Tags.

1.2 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2013.

1.3 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements, for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- B. Size: 1/2 inch high letters unless otherwise noted.
- C. Size when located on ceiling grid: 3/8 inch high letters with 3/4 " x 2" nameplate unless otherwise noted.

2.2 TAGS

- A. Manufacturers: Brimar, Kolbi, Seton.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

- C. Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.3 PIPE MARKERS

- A. Manufacturers: Brimar, Seton Name Plate Co Setmark, Kolbi Industries Style A thru E(5 inch and smaller) else Style F thru H, Marking Services Inc.
- B. Color: Conform to ASME A13.1.
- C. Pipe Markers for Indoor Use: Seton Setmark; media indicator with direction-of-flow arrows on calendared vinyl sheet; snap-around type for pipe sizes to 5-7/8 inches diameter, strap around type with nylon ties for pipe sizes 6 inches diameter and larger.
- D. Pipe Markers for Outdoor Use: Seton Weather-Code; media indicator and detachable direction-of-flow arrows on weather-resistant pressure-sensitive vinyl sheet; service temperature -40 to 175 degrees F.

2.4 VALVE TAGS

- A. Manufacturers: Brimar, Kolbi, Marking Services Inc., Seton.
- B. Valve Tags: Polished Brass 1-1/2 inches diameter; Media and identification number imprinted with black color fill on tag.
 - 1. Tag shapes shall be round for Plumbing, square for HVAC, and octagonal for Fire Protection.
 - 2. Valve tag numbering scheme shall be run consecutively regardless of service with no duplication of numbers throughout the project.
- C. Brass; Media and identification number imprinted on tag.
- D. Valve Tag Securing Devices: Number 6 brass bead chain; provide one securing device for each tag in accepted schedule.
- E. Valve Chart Frame: Aluminum frame, plastic window; sized to accommodate included chart, 8-1/2 by 11 inches.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.

- C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- D. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- E. Identify air handling units, fans, boilers, pumps, cooling towers, heat pump units, and other heat transfer equipment with plastic nameplates.
- F. Identify small devices, such as in-line pumps, with tags.
- G. Where equipment is located above ceilings; Apply nameplate to ceiling grid adjacent to panel to be removed for access for equipment located above accessible ceilings or to access panel for non-accessible ceilings. Color and legend as follows:
 - 1. WSHP's: Black with White Letters. "VAV BOX".
 - 2. Fire Dampers: White with Red Letters. "FIRE DAMPER".
 - 3. Smoke Dampers: White with Red Letters. "SMOKE DAMPER".
- H. Where manual air vents are located above ceilings; Apply nameplate to ceiling grid for equipment located above accessible ceilings or to access panel for non-accessible ceilings.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify equipment by equipment mark scheduled.
- K. Where equipment is located above ceilings, in addition to the nameplate provided for the device; Apply a separate nameplate to ceiling grid adjacent to panel to be removed for access for equipment located above accessible ceilings, or to access panel for non-accessible ceilings.
- L. Tag automatic controls, instruments, and relays. Key to control schematic.
- M. Identify thermostats relating to fans and heat pump units with nameplates.
- N. Install Pipe Markers on all piping systems at the following Locations:
 - 1. Mechanical Equipment Rooms:
 - a. Within 18 inches of each valve.
 - b. Within 36 inches of each 90° elbow, tee, connection to equipment or vessel and point where pipe exits room.
 - c. At not over 20 feet intervals along all exposed piping.
 - 2. Above Suspended Ceilings:
 - a. Within 18 inches of each valve or valve assembly.
 - b. At tees, identify both main and branch within 36 inches of tee.
 - c. Within 36 inches of each 90° elbow.
 - d. At not over 30 feet intervals along all concealed piping.
 - 3. Concealed Piping in Chases or Shafts: Identify each pipe visible through access door panel.
 - 4. Piping Exposed in Rooms Other Than Mechanical Equipment Areas:

- a. Omit identification on piping, 1 inch exterior diameter or smaller(insulated or uninsulated) or exposed at connections to equipment or plumbing fixtures.
 - b. With the above exception, identify at not less than one point each piping run visible in each room, with identification on not over 20 feet intervals.
5. Abandoned Piping: Provide identification pipe markers on existing piping that is taken out of service and remains in place, where noted on the plans. Identify as "ABANDONED PIPING".

O. Valve Tags:

1. Install valve tags on all valves in the mechanical equipment rooms.
2. Identify valves in all riser mains and branch piping with tags.
3. Valve Chart: List all tagged valves indicating system, valve identification number, location and purpose or special information. Mount to wall in mechanical room.

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct leakage testing of 4 inch WG pressure class or higher ducts.
- B. Initial testing, adjustment, and balancing of air systems.
- C. Winter and Summer Seasonal testing, adjustment, and balancing of air systems.
- D. Initial testing, adjustment, and balancing of hydronic systems.
- E. Field quality-control testing of Laboratory fume hoods.
- F. Winter and Summer Seasonal Testing, adjustment, and balancing of hydronic systems.
- G. Measurement of final operating condition of HVAC systems.
- H. Testing of control sensors, controllers and safeties.
- I. Testing, adjustment, and balancing of existing equipment and systems modified by this project.
- J. Commissioning support activities.

1.2 RELATED REQUIREMENTS

- A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B. Section 23 0800 - Commissioning of HVAC System.
- C. Section 23 3100 - HVAC Ducts and Casings: Ductwork Pressure Class.
- D. Section 23 3100 - Air Duct Accessories.

1.3 REFERENCE STANDARDS

- A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.
- B. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems; 2015, Eighth Edition.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit to the Construction Manager.
 - 3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 4. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Identification and types of measurement instruments to be used and their most recent calibration date.
 - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - e. Final test report forms to be used.
 - f. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - g. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - h. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - i. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - j. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - k. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - l. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - m. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C. Field Logs: Submit at least twice a week to the Commissioning Authority.

- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Initial Review: Submit results of testing and balancing agency's examination of documents and systems within 30 days after Notice to Proceed.
- F. Initial Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Submit prior to Contractor's Request for Substantial Completion.
 - 2. Submit to the Construction Manager and Design Professional within two weeks after completion of testing, adjusting, and balancing.
 - 3. Initial report shall be separate from the two seasonal reports and will not be considered a winter or summer seasonal report.
 - 4. Submit copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 5. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - 6. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 7. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 8. Units of Measure: Report data in I-P (inch-pound) units only.
 - 9. Test Reports: Indicate data on AABC MN-1 forms or NEBB forms.
 - 10. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Design Professional.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
- G. Seasonal Reports (Two): Submit seasonal report within 14 days of completion of seasonal adjustments. Include test reports for any equipment that could not be tested at the initial report due to season, temperature or other conditions.
 - 1. List of deficiencies noted, adjustments made and corrective action taken.
 - 2. Temperature of each conditioned space and dry bulb setting of controlling thermostat.
 - 3. Temperature at all sensors in equipment, space duct or pipe and settings of controllers.
 - 4. Date and outdoor DB and WB range during the time of the seasonal test.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC MN-1, AABC National Standards for Total System Balance.
 - 2. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project. Testing shall not be started until the building envelop is completed, ceilings installed, interior and exterior doors and windows are in place.
- C. The Test and Balance contractor shall observe all ductwork leakage testing performed for medium pressure ductwork, as specified in Section 23 3100 - HVAC Ducts and Casings.
- D. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures.
- E. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of five years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - 4. Company shall an independent firm with no relationship with any Contractor on this Project.
 - 5. Company performing the Testing and Balancing of the mechanical systems shall have demonstrated proficiency in the testing, balancing, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least Twenty (20) commercial or institutional buildings, each containing a minimum of 250 tons capacity or greater with ducted air distribution and chilled water or water source heat pump systems, incremental units excluded.
- F. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor experienced in performance of this Work.
- G. Reports shall be certified by a AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor experienced in performance of this Work.

3.2 EXAMINATION

- A. Review the contract documents for appurtenances and arrangement for balancing prior to the installation of any equipment or material. the Contractor shall notify Architect of any omissions noted within 30 days of the Contractor's notice to proceed.
- B. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. All filters are clean and in place. If required, install temporary media in addition to filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place, accessible, operable and open. Report observation on test report.
 - 8. Smoke dampers are in place, damper and operator are accessible, damper is operable, and open. Report observation on test report.
 - 9. All dampers and operators function smoothly from shut-off to full open.
 - 10. Air coil fins are cleaned and combed.
 - 11. Access doors are installed at specified components are accessible, are closed and duct end caps are in place.
 - 12. Air outlets are installed and connected.
 - 13. Duct system leakage is minimized.
 - 14. Hydronic systems are flushed, filled, and vented.
 - 15. Pumps are rotating correctly.
 - 16. Proper strainer baskets are clean and in place.
 - 17. Service and balance valves are open.
- C. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. Testing of equipment shall be simultaneous where components of a systems are connected; e.g. DX coil and condensing unit.
- D. Provide additional balancing devices as required. At no additional cost to the University, the contractor shall adjust or replace impellers, pulleys, sheaves, belts, dampers, and other similar devices as needed for correct operation of mechanical systems.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Laboratory Spaces:
 - 1. Air Inlets: Adjust total to within plus 5 percent and minus 0 percent of design to space. Adjust inlets in each space to within plus 5 percent or minus 5 percent of design.
 - 2. Fume Hoods: Adjust for 80 - 100 FPM average face velocity with the sash at 18 inches above the work surface.
 - 3. Air Outlets: Adjust total to within plus 0 percent and minus 5 percent of design to space. Adjust outlets in each space to within plus 5 percent or minus 5 percent of design.
 - 4. Ensure tolerances result in airflow from the corridors or adjacent non-laboratory spaces into each laboratory.
- D. Building Pressure: Ensure that installation tolerances result in each floor of the building being positively pressurized with respect to outside ambient pressure.
- E. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.6 AIR SYSTEM PROCEDURE

- A. Pressure test ducts in accordance with SMACNA HVAC Air Duct Leakage Test Manual.

1. 4 inch WG or higher: Class 6 for rectangular ducts and Class 3 for round and oval ducts.
- B. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- C. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct. Close openings after measurement with permanent manufactured plugs.
- D. Measure air quantities at air inlets and outlets.
- E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- F. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- G. Vary total system air quantities by adjustment of fan speeds by drive sheave adjustment. Provide drive changes required to place belt in mid-position at final RPM. Vary branch air quantities by damper regulation.
- H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- I. Measure static air pressure conditions on air supply units, including pressure drops at all components including filters and fans, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Adjust operators on outside air dampers to ensure tight seal when shut.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. The differential at the time of balance between the outside and return air streams shall be 15 degrees F, minimum, when the outside air quantities are established by temperature differential.
- M. Where modulating dampers are provided, take measurements and balance at extreme conditions.
- N. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.03 inches positive static pressure near the building entries.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.

- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 COMMISSIONING

- A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.
- F. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.
- G. A copy of the final TAB report shall be submitted to the CxA for the TAB performance verification phase of the commissioning procedures.
- H. The TAB agency shall provide one (1) technician with full instrumentation for the purpose of verifying selected performance submitted in the final TAB report. The verification will be conducted by the CxA.

3.9 CONTROL SYSTEM PROCEDURE

- A. Low Limit Thermostats, Fire Thermostats, Smoke Detectors and other Safety devices: Test and verify operation. Record setpoint.

- B. Sequence of Operation: Operate systems thru specified Sequence and confirm system function.
- C. Thermostats, Input/Output sensors and Controls: Measure temperature or flow at device and record measurement and setting of controller.
- D. Flow rate transducers: Calibrate flow meters. Confirm accuracy of flow meter by testing thru a four point operating range.
- E. Airflow measuring stations: Calibrate flow measuring stations. Confirm accuracy by testing thru a four point operating range.
- F. Humidistats, Humidity Input/Output sensors and Controls: Measure temperature and relative humidity at device and record measurement and setting of controller.

3.10 BALANCE UNDER SEASONAL OPERATING CONDITIONS

- A. After the Initial Balance has been completed, reviewed and accepted; the contractor shall balance and adjust the system under seasonal operating conditions by performing operational tests under both cooling and heating conditions.
- B. These tests shall be performed only after each piece of equipment has been individually tested, and is verified to be in correct operating condition, and shall be made at times when outdoor dry bulb temperatures are above 85 F for cooling (summer seasonal), or below 50 F for heating (winter seasonal).
- C. When test is run during the cooling cycle the building must be occupied (summer seasonal only), and all lights shall be turned on for a minimum of six (6) hours. Doors to all spaces shall be closed and all space thermostats set at its normal setpoint.
- D. Purpose: Prove correctness of installation; prove functioning of capacity and safety controls; prove calibration of operating controls; and prove stability of operation under actual loading conditions.
- E. Notify owner a minimum of one week in advance of the seasonal testing and request that filters be clean at time of testing.

3.11 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Boilers
 - 2. HVAC Pumps
 - 3. Cooling Towers (Circuit Coolers)
 - 4. Air Cooled Condensing Units
 - 5. Enthalpy Recovery Wheels
 - 6. Plate Heat Exchanger
 - 7. DOAS-Air Handling Units
 - 8. Water Source Heat Pump Units
 - 9. Fans

10. Air Filters.
11. Air Terminal Units.
12. Air Inlets and Outlets

3.12 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer
2. Model/Frame
3. HP/BHP
4. Phase, voltage, amperage; nameplate, actual, no load
5. RPM
6. Service factor
7. Starter size, rating, heater elements
8. Sheave Make/Size/Bore

B. V-Belt Drives:

1. Identification/location
2. Required driven RPM
3. Driven sheave, diameter and RPM
4. Belt, size and quantity
5. Motor sheave diameter and RPM
6. Center to center distance, maximum, minimum, and actual

C. Pumps:

1. Identification/number
2. Manufacturer
3. Size/model
4. Impeller
5. Service
6. Design flow rate, pressure drop, BHP
7. Actual flow rate, pressure drop, BHP
8. Discharge pressure
9. Suction pressure
10. Total operating head pressure
11. Shut off, discharge and suction pressures
12. Shut off, total head pressure
13. Plot actual operating point on pump curve chart.

D. Combustion Equipment:(test under high fire and lowest fire conditions)

1. Boiler manufacturer
2. Model number
3. Serial number
4. Firing rate
5. Gas pressure at meter outlet
6. Gas flow rate
7. Heat input
8. Burner manifold gas pressure
9. Percent carbon monoxide (CO)

10. Percent carbon dioxide (CO₂)
 11. Percent oxygen (O₂)
 12. Percent excess air
 13. Flue gas temperature at outlet
 14. Ambient temperature
 15. Heat output (Inlet and outlet water temperatures and flow at time of test)
 16. Boiler pressure
- E. Air Cooled Condensers/Condensing Units:
1. Identification/number
 2. Location
 3. Manufacturer
 4. Model number
 5. Serial number
 6. Entering DB air temperature, design and actual
 7. Leaving DB air temperature, design and actual
 8. Number of compressors
- F. Cooling Towers (Circuit Coolers):
1. Tower identification/number
 2. Manufacturer
 3. Model number
 4. Serial number
 5. Rated capacity
 6. Entering air WB temperature, specified and actual
 7. Leaving air WB temperature, specified and actual
 8. Ambient air DB temperature
 9. Tower water entering temperature
 10. Tower water leaving temperature
 11. Fan RPM
- G. Heat Exchangers (Circuit Cooler):
1. Manufacturer
 2. Model number
 3. Serial number
 4. Tower water entering temperature, design and actual
 5. Tower water leaving temperature, design and actual
 6. Tower water flow, design and actual
 7. Tower water pressure drop, design and actual
 8. Condenser loop entering temperature, design and actual
 9. Condenser loop leaving temperature, design and actual
 10. Condenser loop water flow, design and actual
 11. Condenser loop water pressure drop, design and actual
- H. Enthalpy Energy Recovery Wheels:
1. Identification/number
 2. Location
 3. Service
 4. Manufacturer
 5. Supply Air flow, design and actual

6. Exhaust Air flow, design and actual
7. Purge Air flow, design and actual
8. Entering air DB temperature, design and actual- Supply and exhaust
9. Entering air WB temperature, design and actual- Supply and exhaust
10. Leaving air DB temperature, design and actual- Supply and exhaust
11. Leaving air WB temperature, design and actual- Supply and exhaust
12. Air pressure drop, design and actual

I. DOAS Units:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air DB temperature, design and actual
7. Entering air WB temperature, design and actual
8. Leaving air DB temperature, design and actual
9. Leaving air WB temperature, design and actual
10. Air pressure drop, design and actual

J. Water Source Heat Pumps:

1. Identification/number
2. Service
3. Manufacturer
4. Motor HP, volts, phase, full load amps
5. Air flow, design and actual
6. Entering air DB temperature
7. Entering air WB temperature
8. Leaving air DB temperature
9. Leaving air WB temperature
10. Condenser water flow, design and actual
11. Water pressure drop
12. Entering and leaving condenser water temperatures (Cooling and Heating conditions)

K. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Water flow, design and actual
11. Water pressure drop, design and actual.
12. Entering water temperature, design and actual.
13. Leaving water temperature, design and actual.

14. Saturated suction temperature, design and actual.
15. Air pressure drop, design and actual.

L. Heating Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

M. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure
12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM
15. Describe filter condition.
16. Plot actual fan operating point on fan curve chart.
17. For energy recovery wheels, provide concurrent entering and leaving dry-bulb and wet-bulb for each airstream.

N. Return Air/Outside Air:

1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature

12. Design outside/return air ratio
13. Actual outside/return air ratio

O. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and actual
6. Total static pressure (total external), specified and actual
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM
12. Plot actual operating point on fan curve chart.

P. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor

Q. Duct Leak Tests:

1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

R. Flow Measuring Stations and Flow Rate Transducers:

1. Identification/number.
2. Size.
3. Manufacturer.
4. Model number.
5. Serial number.

6. Design Flow rate.
7. Design pressure drop.
8. Actual/final pressure drop.
9. Actual/final flow rate.
10. Station calibrated setting.

S. Terminal Unit Data:

1. Manufacturer.
2. Type
3. Identification/number.
4. Location.
5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure at 1 foot upstream of unit inlet

T. Air Distribution Tests:

1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow
11. Relative position of balancing damper

U. Space Temperature and Humidity:

1. Temperature and humidity (whether controlled or not) of each conditioned space
2. Setpoint of each controlling thermostat or humidity sensing device.

END OF SECTION 23 0593

SECTION 23 0713 - DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation
- B. Duct Liner
- C. Insulation jackets

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.

1.3 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2010.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014.
- D. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.
- E. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2012.
- F. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2011.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association 2007.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site 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 mechanical damage, by storing in original wrapping.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturers: Certainteed, Knauf, Owens-Corning, JohnsManville.
- B. Insulation: ASTM C 553; flexible, noncombustible blanket.
 - 1. 'K' value: 0.25 at 75 degrees F, when tested in accordance with ASTM C 518.
 - 2. Maximum Service Temperature: 250 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent by weight.
 - 4. Thickness: 2 inches.
 - 5. Density: 1.0 lb./cu ft.

- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- E. Tie Wire: Annealed stainless steel, 16 gage.

2.3 GLASS FIBER, RIGID

- A. Manufacturers: Certaineed, Knauf, Owens-Corning, JohnsManville.
- B. Insulation: ASTM C 612; rigid, noncombustible board.
 - 1. 'K' value: 0.23 at 75 degrees F, when tested in accordance with 1.
 - 2. Maximum service temperature: 450 degrees F.
 - 3. Maximum Water Vapor Sorption: 5.0 percent.
 - 4. Minimum Density: 3 lb./cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.029 ng/Pa s m (0.02 perm inch), when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell International AP.
 - 2. Halstead.
 - 3. Johns Manville Corporation.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 1, in sheet form.
 - 1. 'K' Value: 0.25 at 75 degrees F.
 - 2. Minimum Service Temperature: -40 degrees F.
 - 3. Maximum Service Temperature: 180 degrees F.
 - 4. Water Absorption: < 1.0 percent by volume, when tested in accordance with ASTM C209.
 - 5. Water Vapor Permeability: 0.05 perm-inches, maximum, when tested in accordance with ASTM E 96.
 - 6. Connection: Waterproof vapor barrier adhesive.

- C. Elastomeric Foam Adhesive: Provide Armaflex 520 adhesive or low VOC spray adhesive. Air dried, contact adhesive, compatible with insulation. No mechanical pinning shall be required.

2.5 JACKETS

- A. Interior Glass Fabric Vapor Barrier Finish:
 - 1. Cloth: Untreated 9 oz./sq. yd. weight plain mesh glass cloth.
 - 2. Blanket: 1.0 lb./cu ft density.
 - 3. Weave: 5x5.
 - 4. Lagging Adhesive: Fire resistant compatible with insulation.
 - 5. Finish: Vinyl emulsion type acrylic, compatible with insulation, white color.
 - 6. Exterior Polyethylene Finish: Latex enamel emulsion type, white.

2.6 DUCT LINER

- A. Manufacturers: Certaineed Toughguard2, Owens-Corning Aeroflex Plus, JohnsManville Permacote Linacoustic HP, Knauf Rigid Plenum Liner.
- B. Insulation: Incombustible glass fiber complying with ASTM C 1071; flexible blanket; impregnated surface and edges coated with acrylic polymer shown to be fungus and bacteria resistant by testing to ASTM G 21.
 - 1. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 - 2. Service Temperature: Up to 250 degrees F.
 - 3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 - 4. Density: 1.5 pcf.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.
- C. Adhesive: Waterproof, low VOC, fire-retardant type, ASTM C916.
 - 1. Manufacturers:
 - a. Design Polymeric; DP 2502 Water Based, Low VOC, Duct Liner Adhesive: www.designpoly.com.com/#sle.
 - b. Benjamin Foster Model 81-60.
 - c. Insul-Coustic Model #225.
 - d. Manville Model SuperSeal.
 - e. Foster 85-50
 - f. Childers CP-127

2.7 ADHESIVES, COATINGS, SEALING COMPOUNDS AND PROTECTIVE FINISHES

- A. Lagging Adhesive and Coating for Glass Cloth Jackets and Other Facings - MIL-A-3316 B, Class 1.
- B. Lap Adhesive for Vapor Barrier Jacket - MIL-A-3316 B, Class 2.
- C. Bonding Adhesives - for securing insulation to metal surfaces - MIL-A-3316 B, Class 2 for temperature up to 200 degree F.

- D. Contact Type Adhesive - For installing flexible unicellular insulation - MIL-A-24179, Type II, Class 1.
- E. Bedding Compound and Joint Sealers - MIL-B-19564A.
- F. Coating Compound - Vapor Barrier Treatment - MIL-C-19565B, Type 1 or II.
- G. Protective Finish Outside of Buildings - Coating Compound MIL-C-19565 B, Type I.
- H. Manufacturers: Childers, Foster, Armstrong, Mon-Eco.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Provide insulation with vapor barrier jackets.
- D. Seal all joints, mechanical fastener penetrations, and vapor barrier penetrations with Vapor Barrier Tape
- E. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
- F. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, duct lined with duct liner, heating coil return bends at terminal units, and expansion joints.
- G. Fiber Glass, Flexible:
 - 1. Do not pull insulation tight around ducts.
 - 2. Lap transverse joints 2 inch, minimum and secure with staples 18 inches on center.
 - 3. Wrap insulation with Tie Wire 18 inches on center, maximum.
 - 4. Install mechanical fasteners not more than 18 inches on center on ducts over 24 inches wide.
 - 5. Provide 24 inch length, minimum, of rigid glass fiber insulation on bottom of ducts supported from trapeze hangers.
- H. Glass Fiber, Rigid:
 - 1. Cut to fit between standing seams and stiffeners to provide 1/2 inch, minimum cover.
 - 2. Secure insulation to ducts with duct insulation adhesive applied to duct to provide 100% coverage and with mechanical fasteners 12 inch on centers, maximum.
 - 3. Butt transverse joints.
 - 4. Secure metal corner beads to all exterior edges.

5. Tape all joints and fastener penetrations with 4 inch wide, minimum, foil scrim kraft tape after pointing clip penetrations with insulating cement.
- I. Weld mechanical fasteners to duct. No glue or stick on allowed.
 - J. Rigid duct insulation exposed in the mechanical equipment rooms or Finished Spaces : Finish with glass cloth adhered with fire resistant adhesive and finished with a white coating.
 - K. Duct Accessories, Duct Mounted Meters and Gages Instruments and Duct Mounted Instrumentation and Other Control Devices:
 1. In conditioned spaces devices shall be left exposed and/or accessible above the insulation vapor barrier jacket for access. Seal to vapor barrier jacket.
 2. In non-conditioned spaces devices shall be insulated within the insulation vapor barrier jacket with the insulation and jacket arranged to provide access.
 3. Accessible devices to include:
 - a. Duct mounted Instrumentation,
 - b. Airflow Measuring Station pressure ports,
 - c. Input/Output Sensors,
 - d. Duct access door handles,
 - e. Volume Control damper handles(MVD),
 4. Damper operators shall be left exposed and/or accessible above the insulation vapor barrier jacket for access. Seal to vapor barrier jacket.
 - L. Duct Liner Locations:
 1. Line supply and return ducts where noted on drawings with 1 inch liner.
 - M. Duct Liner Application:
 1. Install liner in accordance with manufacturer's Published Installation Instructions and SMACNA Installation Standards including Figure No. 7-11 and 7-12.
 2. Adhere insulation with adhesive for 90 percent coverage.
 3. Secure insulation with mechanical liner fasteners, type 3 or 4 located in accordance with SMACNA Figure 7-11. Refer to SMACNA (DCS) Standards for spacing.
 4. Install with longitudinal and transverse joints under compression.
 5. Seal and smooth all longitudinal and transverse joints, field cuts exposed edges and any minor surface damage with edge coat.
 6. Seal liner surface penetrations with edge coat.
 7. Provide 26 gauge metal nosing on leading edge at fan discharges and at any interval of lined duct proceeded by unlined duct.
 8. Terminate liner at duct mounted accessories such as turning vanes and dampers. Provide sheet metal "hat" section build out in accordance with SMACNA Figure 7-13.
 9. Duct dimensions indicated are net metal inside dimensions required for air flow. Do not Increase duct size to allow for insulation thickness.
 10. Provide protection for surfaces that may be subject to damage by tradesmen installing electrical, controls or other work.

3.3 CLEANING

- A. Clean adjacent surfaces, valves, valve handles, etc. of jacketing materials.

3.4 SCHEDULES

- A. Exhaust Ducts Within 10 ft of Exterior Openings/Termination (existing building):
 - 1. Glass Fiber, Flexible; 2 inch thick (minimum installed R value:6).
- B. Exhaust Ducts (new building):
 - 1. Concealed and Exposed Above 10ft Above Finished Floor - Glass Fiber, Flexible; 2 inch thick (minimum installed R value:6).
 - 2. Exposed Below 10ft Above Finished Floor - Glass Fiber, Rigid. 2 inch thick with glass fabric vapor barrier jacket (minimum installed R value:6).
 - 3. Exterior Exhaust Ducts Connected to DOAS unit(s): Two layers of Flexible Elastomeric insulation; 2 inch thick total thickness (minimum installed R value:16) protected with glass mesh jacket. Apply layers of insulation with staggered laps and seams. Top surface shall be sloped to prevent pooling of water.
- C. Supply Ducts ducts:
 - 1. Concealed and Exposed Above 10ft Above Finished Floor: Glass Fiber, Flexible; 2 inch thick (minimum installed R value:6).
 - 2. Exposed Ducts in Mechanical Rooms and Non-Conditioned Spaces Below 10ft Above Finished Floor: Glass Fiber, Rigid; 2 inch thick with glass fabric jacket (minimum installed R value:6).
 - 3. Exposed Ducts in Conditioned Spaces: Do Not Insulate.
 - 4. Tops of Ceiling diffusers: Glass Fiber, Flexible; 2 inch thick (minimum installed R value:6).
 - 5. Exterior Supply Ducts: Two layers of Flexible Elastomeric insulation; 2 inch thick total thickness (minimum installed R value:16) protected with glass mesh jacket. Apply layers of insulation with staggered laps and seams. Top surface shall be sloped to prevent pooling of water.
- D. Return Ducts:
 - 1. Concealed and exposed in Mechanical Rooms and Non Conditioned Interior Spaces: Glass Fiber, Flexible; 2 inch thick (minimum installed R value:6).
 - 2. Return Ducts in Conditioned Space or Ceiling Return Air Plenum: Do Not Insulate.

END OF SECTION 23 0713

SECTION 23 0719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 23 2113 - HYDRONIC PIPING: Placement of hangers and hanger inserts.
- C. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2013).
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2013).
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- F. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2015.
- G. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2015.
- H. ASTM D1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2014.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.

- K. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association 2007.
- L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. All insulation, mastics, coatings, sealants, and adhesives shall be certified by the manufacturer to be Asbestos-free.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum Three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER

- A. Manufacturers:
 - 1. Johns Manville Corporation: www.jm.com.

2. Owens Corning Corp: www.owenscorning.com.
 3. CertainTeed Corporation: www.certainteed.com.
- B. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
 2. Maximum service temperature: 650 degrees F.
 3. Maximum moisture absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: Factory applied white kraft paper with glass fiber yarn, bonded to aluminized film with self-sealing lap and butt strips; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Insulating Cement/Mastic:
1. ASTM C195; hydraulic setting on mineral wool.
- F. Insulating Cement:
1. ASTM C449/C449M.

2.3 CELLULAR GLASS

- A. Manufacturers:
1. Pittsburgh Corning Corporation: www.foamglasinsulation.com/#sle.
- B. Insulation: ASTM C552, Grade 1.
1. 'K' value: 0.37 at 100 degrees F.
 2. Service Temperature: Up to 900 degrees F.
 3. Water Vapor Permeability: 0.005 perm inch.
 4. Water Absorption: 0.2 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
1. Armacell AP: www.armacell.us.
 2. Aerocel; Tube.
 3. K-Flex USA; Insul-Tube.
- B. Insulation: Preformed flexible closed-cell elastomeric rubber insulation complying with ASTM C 534 Grade 1; use molded tubular material. Split tube installation is prohibited.
1. 'K' ('Ksi') value: 0.25 at 75 degrees F (0.04 at 24 degrees C).
 2. Maximum Moisture Absorption: < 1.0 percent (pipe) by volume, when tested in accordance with ASTM C 209.
 3. Water Vapor Permeability: 0.05 perm-inches, when tested in accordance with ASTM E 96.
 4. Minimum Service Temperature: -40 degrees F.
 5. Maximum Service Temperature: 220 degrees F.
 6. Connection: Waterproof vapor barrier adhesive.

- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 JACKETS

- A. PVC Plastic:
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 15 mil.
 - e. Connections: Brush on welding adhesive.
 - 2. Covering Adhesive Mastic:
 - a. Compatible with insulation.
- B. ASJ (All Service Jacket): Factory applied white kraft and foil laminate, reinforced, fire retardant jacket (ASJ) with self-sealing lap and butt strips. Jackets shall meet the requirements of ASTM C1136.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.020 inch sheet.
 - 2. Finish: Stucco Embossed.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.6 STAPLES, BANDS, AND WIRES

- A. Staples shall be outward clinching type of type 304 or 316 stainless steel, or monel.
- B. Bands shall be galvanized steel, aluminum, brass, or nickel copper alloy, of 3/4 inch nominal width. The band thickness exclusive of coating shall be not less than 30 gauge for steel and nickel copper alloy.
- C. Wire shall be 18-gauge stainless steel.

2.7 ADHESIVES, COATINGS, SEALING COMPOUNDS AND PROTECTIVE FINISHES

- A. Lagging Adhesive and Coating for Glass Cloth Jackets and Other Facings - MIL-A-3316 B, Class 1.
- B. Lap Adhesive for Vapor Barrier Jacket - MIL-A-3316 B, Class 2.
- C. Bonding Adhesives - for securing insulation to metal surfaces - MIL-A-3316 B, Class 2 for temperature up to 200 degree F.

- D. Contact Type Adhesive - For installing flexible unicellular insulation - MIL-A-24179, Type II, Class 1.
- E. Bedding Compound and Joint Sealers - MIL-B-19564A.
- F. Coating Compound - Vapor Barrier Treatment - MIL-C-19565B, Type 1 or II.
- G. Protective Finish Outside of Buildings - Coating Compound MIL-C-19565 B, Type I.
- H. Manufacturers: Childers, Foster, Armstrong, Mon-Eco.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations. Exterior of insulation shall be uniform in appearance.
- D. Insulation jacket shall fit snug to insulation.
- E. Valves and fittings:
 - 1. Insulate pipe and all valves and fittings including valve bonnets on exterior tower water, refrigerant suction, and A.C. condensate drain piping. Leave only valve stems, open ends of wells and gauge cocks exposed.
 - 2. All Other Piping: Insulate pipe and fittings, but omit insulation on unions and valves. Taper insulation ends and cover with jacket material.
- F. Insulation at Hangers: Hangers for horizontal, A.C. condensate drain, refrigerant suction, and trapeze supports shall be outside of insulation with saddles as specified herein.
- G. Saddles:
 - 1. Provide galvanized steel saddles at each point where pipe insulation passes through a hanger or rests on a support.
 - 2. Saddles shall be 180 arc for horizontal piping, 360 arch for vertical piping.
 - 3. Center saddle on pipe hanger.
 - 4. Length and gauge of saddle shall be as follows:
 - a. 2 inch pipe size and smaller: 18 Gauge saddle, 8 inch long, minimum.
 - b. 2-1/2 & 3 inch pipe size: 18 Gauge saddle, 12 inch long, minimum.
 - c. 4 inch pipe size: 16 Gauge saddle, 16 inch long, minimum.
 - d. 6 inch pipe size and larger: 16 Gauge saddle, 24 inch long, minimum.

- H. Flexible elastomeric cellular rubber insulation: Install without splitting and under compression during pipe fabrication. Seal Joints with adhesive. Paint exposed insulation with two coats of vinyl insulation paint after adhesive has dried for twelve hours, minimum. Allow two hours, minimum, between coats.
- I. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.3 CLEANING

- A. Clean adjacent surfaces, valves, valve handles, etc. of jacketing materials.

3.4 SCHEDULES

- A. Boiler Loop Hot Water System:
 - 1. Heating Water Supply and Return: 2 inch thick glass fiber with factory PVC finish jacket.
- B. DX Cooling Systems:
 - 1. Refrigerant Suction: 3/4 inch thick preformed flexible elastomeric cellular rubber insulation.
 - 2. Refrigerant Liquid (Ductless Split Systems): 3/4 inch thick preformed flexible elastomeric cellular rubber insulation.
- C. Condenser Water Systems:
 - 1. Inside Building: Do not insulate.
 - 2. Exposed Tower and Condenser Water Supply and Return Piping at Cooling Tower: 1-1/2 inch thick cellular glass with aluminum jacket.

3. Exposed Tower Water Drain Piping at Cooling Tower: 1-1/2 inch thick cellular glass with aluminum jacket.
- D. Condensate Drains from Cooling Coils: 1/2 inch thick preformed flexible elastomeric cellular rubber insulation.
- E. Miscellaneous vent or drain piping subject to condensation: 1/2 inch thick preformed flexible elastomeric cellular rubber insulation.

END OF SECTION 23 0719

SECTION 23 0913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Input/Output Sensors:
- B. Control panels.
- C. Thermostats.
- D. Control valves.
- E. Automatic dampers.
- F. Damper operators.
- G. Flow rate transducers.
- H. Input/Output Sensors.
- I. Miscellaneous accessories.

1.2 RELATED REQUIREMENTS

- A. Section 23 0519 - METERS AND GAGES FOR HVAC PIPING: Thermometer sockets, gage taps.
- B. Section 23 2113 - HYDRONIC PIPING: Installation of control valves, flow switches, temperature sensor sockets, gage taps.
- C. Section 23 3300 - AIR DUCT ACCESSORIES: Installation of automatic dampers.
- D. Section 23 0923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- E. Section 26 0519 - Low-Voltage Electrical Power and Conductors & Cables.
- F. Section 26 2726 - Wiring Devices: Elevation of exposed components.
- G. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2012.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

1.4 SUBMITTALS

- A. Refer to Section 23 0510- General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Control valve data: Include manufacturer's product data and schedule indicating body type, size, flow rate, pressure drop, actuators and motors, end switches, normal (failure) position, and maximum differential pressure at which valve is capable of full closure for each valve.
- D. Control damper data: Include manufacturer's product data and schedule indicating damper type, size, flow rate, pressure drop, leakage rate, actuators and motors, end switches and normal (failure) position for each damper.
- E. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- F. Samples: Submit two of each type of room thermostat and cover.
- G. Manufacturer's Instructions: Provide for all manufactured components.
- H. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
- I. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Refer to Section 23 0923, Direct-Digital Control System for HVAC for installer Qualifications for the Company performing the work of this section.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.2 AIRFLOW MEASURING STATIONS (AFMS):

- A. Airflow Measuring Stations (AFMS):

1. Manufacturer: Tek-Air Systems - IAQ 2000 for OA
2. Provide airflow/temperature measurement devices for measurement of outside air and other locations where shown on the plans.
3. IAQ 2000:
 - a. Install in outside air intake openings or ducts and measure outside air from specified minimum up to 100 percent outside air.
 - b. Airflow measuring devices shall be probe shall be "golf ball pattern" differential pressure type probe complete with auto-zero valve and ambient temperature sensor. Transducer shall be mounted in a sealed NEMA 4 enclosure, suitable for mounting in the outdoor air plenum. Weather tight connection cables with weatherproof connectors shall be provided. Cable shall be plenum rated.
 - c. Monitor airflow within accuracy of +/-5 percent of reading over the range of 1000 to 200 FPM and +/-10% over the range of 200 to 75 FPM.
4. Transmitters:
 - a. Each station shall be provided with a single microprocessor- based transmitter operating on 24 VAC with connecting cables. Transmitter shall have an LCD display for air flow and temperature.
 - b. Each transmitter shall be capable of communicating with the BAS controls system using a linear analog output signal, 4-20mA.

- B. Airflow Measuring Stations (AFMS):

1. Manufacturers: JCI AD-1252, Ebtron-GTX Series, Air Monitor Electra-Flo.
2. Provide airflow/temperature measurement devices for measurement of outside air where shown on the plans. Duct mounted sensors shall be fabricated of aluminum alloy tubing with 304 stainless steel mounting brackets. The equipment submittal shall indicate the number of sensors for each airflow measuring station based on duct arrangement and location.
3. Each station shall consist of one or more multi-point measuring probes using thermal dispersion technology, and a single microprocessor- based transmitter.
4. The operating airflow range shall be 0-5000 FPM. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range.
5. Transmitters:
 - a. Each station shall be provided with a single microprocessor- based transmitter operating on 24 VAC with connecting cables. Transmitter shall have an LCD display for air flow and temperature.
 - b. Each transmitter shall be capable of communicating with the BAS controls system using a linear analog output signal, 4-20mA.

- C. Outside Air Measuring Stations (AFMS-OA):
1. Manufacturers: Ebtron-GTX Series, Air Monitor Electra-Flo.
 2. Provide airflow/temperature measurement devices for measurement of outside air where shown on the plans. Duct mounted sensors shall be fabricated of aluminum alloy tubing with 304 stainless steel mounting brackets. The equipment submittal shall indicate the number of sensors for each airflow measuring station based on duct arrangement and location.
 3. Each station shall consist of one or more multi-point measuring probes using thermal dispersion technology, and a single microprocessor- based transmitter operating on 24 VAC with connecting cables. Transmitter shall have an LCD display for air flow and temperature.
 4. The operating airflow range shall be 0-5000 FPM. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range.
 5. Each transmitter shall be capable of communicating with the building DDC controls system using a linear analog output signal, 0-10VDC or 4-20mA.

2.3 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet; with pilot lights, push buttons, and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with hinged, lockable face panel.
- C. Finish: Baked enamel factory finish.
- D. Provide common keying for all panels with two keys per control panel.
- E. Nameplates:
1. Use device identification and number from control drawings.
 2. Identify panel with permanent label mounted on panel face. Nameplate shall be bakelite with white letters, 3/8 inch minimum height.
 3. Identify all panel mounted devices with permanent label mounted adjacent to device. Nameplates shall be bakelite with white letters, 1/8 inch minimum height.
- F. Door mounted devices: Refer to the Sequence of Operation for devices specified to be door mounted.
- G. Wiring:
1. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip.
 2. Power supply of capacity required with disconnect switch, surge protection, fuse holder with fuses or circuit breaker, 120 VAC service receptacle wired from the same circuit serving the DDC controller.
 3. Conductors color coded with both ends identified with manufactured alpha-numeric self-adhesive vinyl tags, 3 mils thick, minimum, keyed to termination points.
 4. Connections and junctions to terminal strips and devices only.
 5. All control wiring shall be run neatly and orderly in open slot wiring duct with cover.

6. Provide a 6"x6" metal wiring trough across the entire width of the panel mounted to the top of the panel with close nipples of sufficient size for additional 50% wiring capacity. Wiring troughs shall not be less than 24" in length. Control panel wiring shall be installed and distributed in the trough to minimize routing of wiring within the control panel.
 7. Complete laminated wiring termination drawings shall be attached to the interior of each panel of sufficient size to be easily readable.
 8. Wiring and devices that derive power from other sources shall be located in a separate compartment and be provide with separate terminal strips.
 9. Cover all line voltage terminations in panel.
- H. Indicator lights: 24 VAC light emitting diode. 100,000 hour lamp life. Provide single "Press-To-Test" button for all lights in panel.

2.4 CONTROL VALVES

A. Globe Pattern:

1. Up to 2 inches: Bronze body, bronze trim, stainless steel rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
2. Over 2 inches: Iron body, bronze trim, stainless steel rising stem, plug-type disc, flanged ends, renewable seat and disc.
3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel.
 - c. Packing: EDPM O-ring.
 - d. Refer to Valve Coefficients indicated on drawings for size.
 - e. Two way valves shall have equal percentage characteristics. Size two way valve operators to close valves against pump shut off head.
4. Electronic Operators:
 - a. Manufacturers: Belimo, JCI.
 - b. Valves shall spring return (reversible) to normal position as indicated on freeze, fire, or temperature protection.
 - c. Select operator for full shut off at 150% design pump head or a 50 psig differential pressure, whichever is greater.
 - d. 24 VAC reversible motor with Class F insulation or better with drive mechanism in enclosure, 10VA maximum.
 - e. Enclosure: Water-proof aluminum cover and base, NEMA-2, IP 54, coupling direct to valve.
 - f. Provide all corrosion resistant (non-ferrous) components, fasteners and mounting devices and connections.
 - g. Unit shall be prewired.
 - h. Valve status display: Color coded visual indicator to display valve position through full range of travel.
 - i. External built-in travel limit switch to reverse direction.
 - j. Manual override with hex operator.

B. Butterfly Pattern:

1. Manufacturers: Bray 31, Crane 12, Hammond 5111, Milwaukee WA, Mueller 51, Nibco WD-2000-3, Stockham LG551.
2. Iron body, aluminum bronze disc, resilient replaceable EDPM seat for service to 180 degrees F wafer or lug ends, stainless steel stem, extended neck.
3. Hydronic Systems:
 - a. Valves shall be rated for bubble-tight closure at a differential pressure equal to the valve body rating.
 - b. Size modulating valves for 2-4 psig maximum pressure drop at design flow rate and 60 degree opening.
 - c. Two-position valves shall be line size.
4. Electric operator:
 - a. Manufacturers: Bray 70, JCI.
 - b. Single phase, permanently split-capacitor, reversible motor with Class F insulation or better with self-locking worm gear drive mechanism in enclosure.
 - c. Enclosure: Water-proof die-cast aluminum cover and base, NEMA-4, 4X, IP 65, polyester powder coated, coupling direct to valve. One power and one control conduit NPT entries.
 - d. Provide all corrosion resistant (non-ferrous) components, fasteners and mounting devices and connections.
 - e. Valve status display: Color coded visual indicator to display valve position through full range of travel.
 - f. SPDT-DB travel limit switches.
 - g. Manual override with aluminum handwheel.
 - h. Stainless steel mechanical travel stops.
 - i. Provide servo control for modulating control sequences.
 - j. Provide heater with thermostat prewired to terminal block for operators located in exterior locations.

2.5 CONTROL DAMPERS

- A. Manufacturers: Arrow 395, Johnson VD-1300, Ruskin CD-60, National Controlled Air SCD-LL-HD-57, TAMCO-1000.
- B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 16 gage.
- C. Blades: Galvanized steel, double thickness airfoil, maximum blade size 8 inches wide, 48 inches long, minimum 16 gage, attached to minimum 1/2 inch shafts with set screws.
- D. Blade Seals: Synthetic elastomeric mechanically attached, field replaceable.
- E. Jamb Seals: Spring stainless steel.
- F. Shaft Bearings: Bronze sleeve, steel ball type, or Cynoloy 800.
- G. Linkage and linkage Bearings: Blade linkage outside of airstream with Oil impregnated sintered bronze bearings.
- H. Leakage: Class 1; 8.0 CFM/Sq.FT.inch maximum at 4-inch W.G. pressure difference.

- I. Pressure Drop: Less than 0.10 inches W.G. based on fully open 48" x 48" damper and an approach velocity of 2000 FPM.
- J. Maximum Pressure Differential: 6 inches wg.
- K. Temperature Limits: -40 to 200 degrees F.

2.6 DAMPER OPERATORS

- A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - 1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - 2. Provide one operator for maximum 15 sq ft of damper section.
- B. Electric Operators:
 - 1. Manufacturers: Belimo, JCI.
 - 2. Spring return, adjustable stroke motor having oil immersed gear train.
 - 3. 24 VAC reversible motor with Class F insulation or better with drive mechanism in enclosure, 10VA maximum..
 - 4. Enclosure: Aluminum cover and base, NEMA-2, IP 54, coupling direct to damper.
 - 5. Provide all corrosion resistant (non-ferrous) components, fasteners and mounting devices and connections.
 - 6. Unit shall be prewired. Provide a conduit fitting.
 - 7. Status display: Visual indicator to display damper position through full range of travel.
 - 8. External built-in travel limit switch to reverse direction.
 - 9. Manual override with hex operator.

2.7 FLOW RATE TRANSDUCER(FRT)

- A. Manufacturers: Data Industrial, Flow Research, Onicon FB.
- B. Probe mounted, low mass rotating element coupled to a transmitter generating a digital pulse train
- C. Unit shall be mounted through a corporation stop permitting removal from active pipe and shall impose no more than three foot pressure drop in pipe.
- D. Unit coupled with DDC microprocessor shall provide an accuracy within +1% of actual flow rate, regardless of span, between 1/2 FPM minimum flow rate and maximum GPM when installed in line size schedule 40 pipe.
- E. Repeatability shall be 0.5% of actual flow rate.

2.8 INPUT/OUTPUT SENSORS

A. Temperature Sensors:

1. Resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
2. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
3. Provide 3 lead wires and shield for input bridge circuit.
4. Use insertion elements in ducts not affected by temperature stratification and smaller than 10 square feet. Use averaging elements where larger or prone to stratification sensor length 8 feet or 16 feet as required.
5. Use sensor holder with mounting plate and conduit enclosure with cover plate for elements mounted on ducts. Provide extension between plate and enclosure on insulated ducts.
6. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches. Provide lagging extensions on insulated pipes.
7. Room Digital Thermostats: Sensor with Warmer-Cooler setpoint adjustment dial, built-in override button, and terminal block wiring connection. Locking blank cover with no temperature display. Setpoint adjustment range shall be 70°-80°F with override capability thru the DDC programming.
8. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.

B. Humidity Sensors:

1. Manufacturer: JCI, Vaisala, Veris, Setra
2. Industrial quality, bulk polymer type, with replaceable element and an accuracy of +2% RH in the range of 20-90% when used for control applications. The sensors should be capable of calibration. Saturation shall not alter calibration. Space humidity sensors should have the same appearance as space temperature sensors.
3. Elements: Accurate within +/- 2% RH over full range with linear output.
4. Room Sensors: With locking cover matching appearance of space temperature sensors.
5. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.

C. Differential Pressure Sensors:

1. Manufacturer: JCI, Setra, Veris
2. Designed for media sensed and for static or differential pressure measurement, as appropriate. The sensor should be capable of withstanding an over range pressure limit of 300% of the normal expected value. Sensor should incorporate a transducer with non-interacting zero and span adjustments. The zero shall be continuously adjustable on outputs.
3. Unidirectional with ranges adjustable from 0-125 percent of maximum expected input.
4. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
5. Accuracy: One percent of full scale with repeatability 0.3 percent.
6. Output: 0 - 5 vdc with power at 12 to 28 vdc.
7. Hydronic Systems - Provide high and low line isolation valves, and parallel pressure gage to pipe to read high/low pressures independently.

8. Low and High Static Pressure Limit - provide hard wired safety function interlock to equipment starter. Provide additional dry contact for monitoring by the DDC System.

D. Equipment Operation Sensors:

1. Status Inputs for Electric Motors:

- a. Status Inputs for Electric Motors: U.L. Listed current sensing relay with split core current transformers, adjustable mounting bracket, power and trip LED indication. Provide with a normally open contact rated at a minimum of 50V peak and 0.5 amps, or 25 VA with adjustable setpoint. Provide a single opening for passage of current carrying conductors. Relays shall be sized for 50% rated current based on the connected load. Voltage isolation shall be a minimum of 600V. There shall be a single opening for passage of current carrying conductors.
- b. Constant speed fans and pumps: Relay trip setpoint at 10% below the normal motor operating speed and current draw.
- c. Variable speed fans and pumps: Relay trip setpoint at 5% below the lowest motor operating speed and current draw as determined in the commissioning process, typically 20%.
- d. Manufacturer: Hawkeye H-900, Kele D-150, Veris Industries.

E. Air Quality Sensor: (CO2)

1. Space or duct mounted sensors as required, dual channel infrared type with 10 micron filter to prevent particulate contamination.
2. Accuracy: +/-5% of reading up to 10000 ppm, with repeatability of +/-20 ppm and maximum drift of +/-10 ppm per year, and a recommended calibration interval of five years. Sensor shall have a response time of no more than 2 min. to 90% of full scale change.
3. Sensor and transmitter shall provide a 4-20 mA output proportional to carbon dioxide concentration, and a relay output indicating setpoint has been exceeded.
4. Manufacturers: Veris, Tel-Aire, Engelhard, JCI.

2.9 SWITCHING DEVICES

A. Electric Relays:

1. Heavy duty, isolated, cabinet mounted, blade plug-in type with base.
2. Rating: 10 amps, minimum at 125 VAC:

2.10 THERMOSTATS

A. Electric Room Thermostats:

1. Type: NEMA DC 3, 24 volts.
2. Covers: Locking with set point adjustment, without thermometer.

B. Line Voltage Thermostats:

1. Dead band: Maximum 2 degrees F.
2. Cover: Locking with set point adjustment, without thermometer.
3. Rating: Motor load.

- C. Room Thermostat Accessories:
 - 1. Insulating Bases: For thermostats located on exterior walls.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Locate all control devices except for sensors and devices integral to equipment within control panels, unless otherwise noted.
- C. Install control devices in a readily accessible location. Refer to definitions in Section 23 0510.
 - 1. Low temperature detectors for freeze protection shall be accessible for annual testing of elements and devices by maintenance personnel.
- D. Coordinate with Contractor and monitor the work so that other trades do not obstruct control devices or other items requiring access for service.
- E. Device mounting:
 - 1. All devices shall be permanently mounted and secured in place.
 - 2. Mount control panels on backboards adjacent to associated equipment on vibration free walls or free standing angle iron supports. Refer to Section 23 0510 for backboards.
 - 3. Panel mounted controls: Secure to panel backs with non-ferrous sheet metal screws.
 - 4. Gypsum Board and Plaster walls: Moly-bolt type anchor. No adhesive or plastic insert anchors.
 - 5. Concrete Walls: Non-ferrous screws and expansion shields.
 - 6. Concrete masonry units: Mount to recessed box or secure with moly-bolt type anchor.
 - 7. Provide accessory wall adapter plates where required to cover block or wall opening edges.

8. Pipe and duct mounted devices: Secure to well or mounting flange. Provide well and flange extensions on insulated duct and pipe to clear insulation thickness.
9. Mount control valves with stem at or above the horizontal.
10. Mount dampers with blades horizontal.

F. Identification:

1. Nameplates: Identify all sensors mounted in mechanical rooms using device ID and number from control drawings with permanent label mounted adjacent to device. Nameplates shall be engraved plastic laminate with uppercase black letters on a white field, 1/4 inch minimum height.
 - a. Include sensor type, normal setpoints information on nameplate.
 - b. Mounting: Attach nameplates with epoxy cement or non-ferrous screws after final painting.
2. Color code conductors with both ends identified with manufactured alpha-numeric self-adhesive vinyl tags, 3 mils thick, minimum, keyed to termination points.

G. Electrical wiring:

1. All control and interlock wiring shall be provided under this section.
2. Control and sensor wiring shall be installed in conduits and shall be separate from AC wiring of any voltage. Conduits to devices in finished spaces shall be concealed.
3. No splices between field devices and control panels are permitted.
4. All Wiring materials and methods shall comply with Division 26 except:
 - a. Minimum wire size shall be 14 AWG(copper) for line voltages.
 - b. Minimum wire size shall be 18 AWG(copper) for signal.
5. Fire Alarm System Interface:
 - a. Signal for fan shutdown shall be obtained from fire alarm output relay located in mechanical room adjacent to the starter/motor control center, unless otherwise noted.
 - b. Wiring for emergency fan shutdown from fire alarm system and manual stations shall be separate from control and sensor wiring and devices.
6. Electric Operators:
 - a. Power wiring for controls provided under Division 26 is shown on the Electrical Drawings. Provide conduit, conductors, power supplies and transformers as required for power to operate electric operators.

H. Airflow Measuring Stations:

1. Install the airflow measuring stations in strict compliance with the manufacturer's recommendation for upstream and downstream straight duct clearances and devices.
2. Mount outside air measuring station transmitter in a location and height that the display can be read, 4'6" to 6'0" above floor.

I. Sensor Mounting:

1. Check and verify location of thermostats and exposed control sensors with plans, furniture layout, and room details before construction of wall assemblies. aligned vertically or horizontally with adjacent light switches
2. Adjustable Devices - Locate 48 inches above finished floor.
3. Concealed Adjustment - Locate 60 inches above finished floor. Concealed setpoint adjustment type space temperature sensors with occupant override push buttons shall be classified as Adjustable type devices.

- J. Mount in center of 8x8 inch block face with recessed mounting box and accessory wall adapter plate covering block opening where mounted in concrete masonry units.
- K. Use a single sensor for outside air temperature.
- L. Mount outdoor thermostats and outdoor sensors indoors, with sensing elements outdoors on north side of building or in shaded location. Mount with sun shield.
- M. Mount outdoor thermostats and outdoor sensors away from building discharge openings or doors where conditioned air from building will effect signal. Do not mount on positive pressurized HVAC devices where conditioned air can leak thru opening effecting signal.
- N. Provide separable sockets for liquid elements. Mount sockets as specified in Section 23 2113 . Cut element to length for full insertion into well and provide conducting compound.
- O. Provide mounting flanges for air bulb elements with extensions as required on insulated ducts to clear insulation.
- P. Install current sensing relays in starter enclosure for equipment served.
- Q. Install control valves in a readily accessible location.
- R. Install control valves with stems upright or horizontal, not inverted.
- S. Differential pressure transducer piping manifold:
 - 1. Tap tubing from side of pipe mains, not top or bottom. Tubing shall be copper or brass.
 - 2. Provide manifold unions across the supply and return mains with isolation valves.
 - 3. Provide a pressure gage across the supply and return mains in parallel with the pressure transducer.
 - 4. Provide test ports across the transducer and a blowdown on each side of the transducer.
 - 5. Install manifold at 5'-0" AFF.
- T. Provide mixing dampers of opposed blade construction arranged to mix streams.
- U. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper operator.
- V. Provide isolation (two position) dampers of parallel blade construction.
- W. Install damper operators in accessible locations.
- X. Install damper operators on outside of duct in warm areas. Do not install operators in locations at outdoor temperatures.
- Y. Mount control panels on backboards adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

- Z. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- AA. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.3 SENSOR AND METER CALIBRATION

- A. Calibration of DDC sensors and metering devices shall be included as part of the pre-functional checklists according to the following procedures and shall be verified during the functional Testing of the commissioning process:
 - B. General: verify that the sensors with shielded cable are grounded only at one end.
 - C. Sensors without external transmitters: take a reading with a calibrated test instrument within 6" of the sensor installation and verify the sensor reading is within the specified tolerance. If not, install offset, calibrate, or replace sensor to obtain required accuracy.
 - D. Sensors with external transmitters: disconnect sensor from transmitter input and connect a signal generator in place of sensor. Using manufacturer's data, simulate minimum measured value. Adjust transmitter potentiometer zero until minimum signal is read. Repeat for the maximum measured value and adjust transmitter until maximum signal is read. Reconnect sensor. Make a reading with a calibrated test instrument within 6" of the sensor installation. Verify that the sensor reading is within the specified tolerance. If not, repeat the process until specified accuracy is achieved, or replace the sensor and repeat process.
 - E. Paired Sensors: for sensor pairs that are used to determine a temperature or pressure difference, calibrate both sensors to a common measurement and verify they are reading within +0.25 Degree F for temperature and within a tolerance equal to +2% of the sensor reading for pressure.
 - F. Proper calibration of sensors shall be demonstrated and documented as part of the commissioning process.

3.4 COMMISSIONING TESTS

- A. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.
- B. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.5 SCHEDULES

- A. Refer to Sequence of Operation for valve normal position and to Drawings for valve coefficients.

B. Refer to Sequence of Operation for damper normal positions.

END OF SECTION 23 0913

SECTION 23 0923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System Description
- B. Controllers
- C. Power Supplies and Line Filtering
- D. Controller Software
- E. Digital control equipment.
- F. Software set-up and application programming.
- G. Owner demonstration and training.

1.2 RELATED REQUIREMENTS

- A. Section 23 0510 -General Mechanical Requirements-Demonstration, Training and Instructions.
- B. Section 23 0514- Variable Frequency Controllers.
- C. Section 23 0913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.
- D. Section 23 0994 - HVAC Sequence of Operation.
- E. Section 23 0810 - Mechanical Commissioning.
- F. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.
- G. Section 26 0519 - Building Wire and Cable.
- H. Section 26 0534- Conduit.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.
- B. B. BTL - BACnet Testing Laboratories.
- C. NFPA 70 - National Electrical Code, 2017 Edition.

1.4 SUMMARY

- A. Existing Building 100:
 - 1. The existing HI Solutions building automation system (BAS) will remain, with upgrades, and be extended to include new equipment as part of the renovation project. The existing BAS shall be retro-commissioned entirely as part of this project prior to start of any construction to verify existing sequences and device accuracy. Renovated areas will include interface of lighting controls into the BAS for programming and space occupancy sequencing.
- B. New Building B:
 - 1. A Building Automation System shall be installed in the new building with connection to the existing campus headend.
 - a. Automatic temperature control field monitoring and control system using field programmable micro-processor based units. Local BAS control panels shall be installed for each major component of the mechanical system for local monitoring and control. Communication between controllers shall be via RS485, communication to 3rd party devices shall be via BACnet.
 - b. The BAS shall be capable of total integration of the facility infrastructure systems with user access to all system data both locally and by remote access via standard Web Browser over the Internet. This shall include HVAC controls, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to building operations. System shall include interface with lighting controls into the BAS for programming and space occupancy sequencing.
 - c. Include controller software and hardware, operator input/output devices, control units, local area network (LAN), sensors, control devices, control valves, dampers, and actuators.
 - d. Control devices shall be factory installed by equipment manufacturers.
- C. The Building Automation System (BAS) shall be comprised of a distributed process network control system complete with all necessary hardware and software including all programming and a complete system of direct digital automatic temperature controls (DDC).
- D. The BAS shall be capable of total integration of the facility infrastructure systems for the new work with user access to all system data both locally over a secure Intranet within the building and by remote access by a standard Web Browser over the Internet. This shall include HVAC controls, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to building operations as indicated on the drawings or in this specification. All hardware and software provided shall be fully compatible with the Owners existing system.
- E. System shall use the BACnet protocol for communication to 3rd party devices. The operator workstation or web server and control modules shall communicate via RS485..
- F. Lighting control shall be incorporated using UL listed lighting relays connected to the associated water source heat pump control(s) which shall monitor the occupancy sensor and fully integrate with the network and operator work station.

1.5 SYSTEM DESCRIPTION

- A. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on BACnet protocol network, with central and remote hardware, software, and interconnecting wire and conduit. Provide Building Controllers (BC), Advanced Application Controllers (AAC), and Application Specific Controllers (ASC) as required to achieve specified sequences and performance.
- B. The contractor shall connect DDC controllers via a field bus, to a network controller or I/P router, to communicate the building DDC data to/from the existing Owner workstation in the Physical Plant office on the campus.
- C. The BAS shall be a Web based system communicating over the campus Local Area Network (LAN). Contractor shall be responsible for coordination with the Owner IT department to ensure that the building automation system will perform in the data network environment without disruption to any of other activities taking place on that LAN. TCP/IP connections and addresses will be provided by the Owner for interface with the network.
- D. The BAS shall support standard Web browser access via Intranet/Internet, supporting a minimum of 5 concurrent users.
- E. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- F. Controls for water source heat pumps, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units.
- G. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- H. Provide all variable frequency Controllers associated with HVAC equipment controlled by the specified sequence of operation. Refer to Section 23 0514. Electrical contractor is responsible for high voltage wiring connection(s).
- I. The Contractor shall be responsible for all equipment, cables, installation, and programming to implement the required interface with the campus network.
- J. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- K. Building lighting controls shall be provided with occupancy sensors in all occupiable spaces. The occupancy sensor shall connect to rooms water source heat pump or RTU controller.

1.6 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:

1. Table of Contents listing sheet titles and sheet numbers.
2. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
3. Provide drawing legend and list of abbreviations.
4. System architecture: Provide a drawing of the proposed system architecture showing configuration and locations for DDC controllers, terminal unit controllers, power and control wiring for each device, and hardware and wiring for connections to networks external to the building.
5. Provide floor plans in electronic and hard copy format locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions coordinated with the work of other trades.
6. DDC system data: Proposed system manufacturer's data sheets on DDC controllers, sensors, meters, relays, actuators, motors, terminal unit controllers, protection devices, and other devices specified herein. Include data on system software packages to be installed and illustrations of proposed graphics displays.
7. Diagrams: Separate field wiring diagrams for each system, motor starting and interlock wiring, ladder diagrams, control wiring, interior electrical circuits of control instruments with terminal and control device designations, actuators and motors, colors of wires, locations of instruments and remote elements, interfaces with communications equipment provided with equipment specified in other Sections, and normal position of relays. Each diagram shall have terminals labeled as they will be marked on the installed equipment. Electrical wiring diagrams shall include diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which is existing, factory-installed and portions to be field-installed.
8. The control submittal is to include schematic control drawings showing the configuration of the equipment, the location of all sensors, monitoring inputs, and controlled devices and any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
9. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). Provide a full points list with the following included for each point:
 - a. Controlled system
 - b. Point abbreviation/acronym
 - c. Point description
 - d. Engineering unit to be displayed with the point
 - e. Control point or set-point (Yes / No)

- f. Monitoring point (Yes / No)
 - g. Intermediate point (Yes / No)
 - h. Calculated point (Yes / No)
10. Proposed Graphics: Submittal shall include all proposed displays as required by the project documents and specifications.
11. Sequences of Operation: Complete detailed sequences of operation, including a narrative of the system operation and interactions and interlocks with other systems; notations indicating whether interlock or interaction is accomplished through software or hard-wired connections; detailed delineation of control between packaged controls and the DDC system; and sequences of operation for packaged controlled equipment that interfaces with the DDC system describing what points the DDC system monitors only and what points are control points and are adjustable. Sequence shall include:
- a. Equipment start-up sequences.
 - b. Warm-up mode sequences.
 - c. Normal operating mode sequences.
 - d. Detailed sequences for all control strategies, e.g., optimum start/stop, capacity control, staging, optimization, etc.
 - e. Temperature and pressure control: setbacks, setups, resets, etc.
 - f. Shutdown sequences.
 - g. Unoccupied mode sequences.
 - h. Sequences for all alarms and emergency shut downs.
 - i. Effects of power or equipment failure with all standby component functions.
 - j. Seasonal operational differences and recommendations.
 - k. Initial and recommended values for all adjustable settings, set-points and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - l. Schedules, if known.
 - m. All sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered
12. BACnet Systems:
- a. BACnet object description, object ID, and device ID, for each I/O point.
 - b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
 - c. Submit PICS indicating the BACnet functionality and configuration of each controller.
13. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.
- a. Drawings and Diagrams: Schematic flow diagrams and system architecture diagrams shall be provided on electronic media as AutoCAD 2005 or later version drawing files. Other drawings and diagrams may be provided as either AutoCAD files or PDF files, as most appropriate.
 - b. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format.

- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
- F. Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 4. Provide maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
 - 5. Provide BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
 - 6. Provide BAS advanced Programming Manuals for each controller type and for all workstation software.
 - 7. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Divisions 1 and 23.
 - 8. Provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description and location information.
 - 9. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.
 - 10. Provide record system architecture riser diagram showing the location of all controllers.
 - 11. Complete original issue diskettes for all software provided, including operating systems, programming language, backup copy of programming code for the controllers in the project, operator workstation software and graphics software.
 - 12. Licenses, guarantees, and warranty documents for all equipment and systems.
 - 13. Maintain project record documents throughout the construction period and submit final documents at Substantial Completion.
- G. Observation by Architect: Provide an affidavit to Architect stating the Controls Systems are performing in accordance with the contract documents prior to Request for Substantial Completion.
- H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- I. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.7 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Personnel: Mechanics and electricians performing this work shall be regularly engaged in the installation of automatic temperature controls and be in the direct employ of the installing company and shall have a copy of the approved submittal data in immediate possession when performing work.
- C. Software/Hardware Installer Qualifications: All automatic controls shall be installed by Frazier Service Co. - Contact: Alex Brown (404)-456-7041
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. All components, system software, and parts furnished and installed by the BAS contractor shall be guaranteed against defects in materials and workmanship for one year from date of Material Completion. Project-specific software, database software, and firmware updates which resolve known software deficiencies as identified by the BAS Contractor shall be provided to the Owner at no charge during the warranty period. All corrective software modifications made during warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
- C. At Substantial Completion, the BAS contractor shall upgrade all control software and firmware packages to the latest release available from the vendor.
- D. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.9 PROTECTION OF SOFTWARE RIGHTS AND LICENSES

- A. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to:
 - 1. Project graphic images
 - 2. Record drawings
 - 3. Project network database
 - 4. Project-specific application programming code
 - 5. All documentation.
- B. The Contractor shall provide additional software licensing as follows:
 - 1. Provide or upgrade all licensing for all software packages at all required workstations. Building automation system licensing shall allow unlimited

simultaneous users for access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

2. All software should be available on all Operator Workstations or servers provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.
3. Provide licensing and original software copies for each Operator Workstation or server.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. H I Solutions - Kennesaw, GA;

2.2 BACnet™ COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers utilize by 3rd party vendors shall comprise a BACnet internetwork. 3rd party equipment and operator interface communication shall conform to the latest edition of ANSI/ASHRAE Standard 135, BACnet.
- B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- C. Web server or workstation shall communicate to 3rd party equipment using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- D. The system shall use BACnet as the native communication protocol between distributed 3rd communicating on the controller network and must, as a minimum, support the following Objects and Application Services:
 1. Objects > Binary Input Services > Readproperty
 2. Binary Output Writeproperty
 3. Binary Value
 4. Analog Input
 5. Analog Output ReadMutipleProperty
 6. Analog Value WriteMultipleProperty
 7. Calendar
 8. Schedules

2.3 OWNER WORKSTATION/CAMPUS SERVER

- A. The contractor shall connect new DDC controllers via a new field bus, to a network controller or I/P router, to communicate the building DDC data to/from the existing BAS PC based owner workstation located in the campus Physical Plant office.
- B. The 100 Building currently has an existing H I Solutions DDC system. It is the intent that this system be expanded and updated as part of this project to accommodate new/added equipment and lighting controls
- C. The contractor shall update the existing PC based BAS workstation as required, to have a single, integrated, and fully functioning BAS. Updates to the web-server shall include but are not limited to:
 - 1. PC hardware computer components
 - 2. Database updates of new controllers, I/O, and BACnet objects/properties
 - 3. Controller programming code
 - 4. Data logging and reports of BAS data
 - 5. Alarm presentation and routing
 - 6. Master time scheduling algorithms
 - 7. Graphical representation of data
 - 8. Graphics adjustment of application parameters (i.e., setpoints)
 - 9. Trending of points.
 - 10. Adjustment of calibration offsets on analog devices.
- D. Application Development
 - 1. Master time schedules shall be programmed through the BAS. Local time schedules will be programmed for each system in the controllers by the contractor and occupancy commands shall be bound from the workstation to the building level controllers by the contractor where the applications require time based control.
 - 2. Other Supervisory Applications
 - a. The contractor shall be responsible for mapping all points (BACnet objects/properties) to/from the controllers to/from the web-server.
 - b. With the exception of master time schedules or optimized start/stop algorithms, all applications shall be programmed within the controllers.
 - c. Within an application program, there are numerous BACnet objects with BACnet properties that must be adjusted from the web-server graphics, during the commissioning of a system and/or be available for adjustment as requirements change by operators. This adjustment shall be done via the server and via web based access through a web browser from any computer (not only through an operator work station) and, as a minimum, the following properties must be available for adjustment from the web interface graphics fed from the web-server:
 - 1) Setpoints
 - 2) Timing parameters
 - 3) PID loop gain
 - 4) PID loop integral time constant
 - 5) PID loop derivative time constant
 - 6) Alarm limits
 - 7) Calibration offsets for analog values
 - 8) Analog input values

- 9) Manual start/stop & open/closed override commands
- 10) Equipment status overrides
- 11) Manual override of analog output values

2.4 BUILDING CONTROL UNITS

- A. Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment. The BC(s) shall provide fully distributed control independent of the operational status of operator work stations or web-servers. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces. Each BC shall provide intelligent, standalone control of HVAC functions. Each BC may be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices.
- B. All controllers other than those used for terminal equipment shall be defined as a BC unit.
- C. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.
- D. All local controller operating parameters, setpoints, and schedules shall be stored in non-volatile EEPROM memory.
- E. Arrange Unit and Unit I/O so that control unit functions continue if communications over network are lost.
- F. Control Units Functions:
 1. Monitor or control each input/output point.
 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 3. Acquire, process, and transfer information to operator station or other control units on network.
 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 5. Access both data base and control functions simultaneously.
 6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
 7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Automatic Temperature Control.
 - c. Event initiated control.
 - d. Calculated point.
 - e. Scanning and alarm processing.
 - f. Full direct digital control.
 - g. Trend logging.
 - h. Global communications.

- G. Global Communications:
 - 1. Broadcast point data onto network, making that information available to all other system control units.
 - 2. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.

- H. Input/Output Capability:
 - 1. Discrete/digital input (contact status) isolated, either N.O. or N.C. as specified.
 - 2. Discrete/digital output: Isolated relay contacts with built-in HOA switch rated for 1 amp at 24 VAC, minimum.
 - 3. Analog input: Compatible with sensors specified in Instruments and Control Elements.
 - 4. Analog Output: Supervised Analog output compatible with operator(0-10VDC, 4-20mA) with built-in HOA and manual positioner, 8 bit minimum.
 - 5. Pulse input (5 pulses/second).
 - 6. Pulse output (0-655 seconds in duration with 0.01 second resolution).

- I. Provide transient protection on all I/O signals where cable or device is external to building.

- J. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Each building controller shall be provided with a minimum of one spare digital and analog output points, and two universal input points.

- K. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

- L. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.

- M. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
 - 1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.
 - 2. Control output points but change only data base state or value; leave external field hardware unchanged.
 - 3. Enable control actions on output points but change only data base state or value.

2.5 TERMINAL UNIT CONTROLLERS

- A. Control of heat pump terminal units is to be accomplished by microprocessor-based stand-alone terminal unit controllers utilizing direct digital control. An individual terminal unit controller shall be provided for each heat pump unit and shall interface to the DDC system. Each terminal unit controller shall contain resident programming which is field-selectable for the specific application. Each terminal unit controller is to be accessible from the central or local operator station and remote operator's terminals for purposes of

control parameter and setpoint adjustment and monitoring. An operator's terminal connected to any DDC controller on the network shall have access to the terminal unit controllers. Terminal unit controllers shall also be accessible through a communications port at the space sensor.

- B. Terminal unit controllers shall be provided by controls vendor for factory installation by heat pump terminal device manufacturer.
- C. All local controller operating parameters, setpoints, and schedules shall be stored in non-volatile EEPROM memory.

2.6 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies:
 - 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 - 2. Limit connected loads to 80 percent of rated capacity.
 - 3. Match DC power supply to current output and voltage requirements.
 - 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 - 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 - 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 - 7. Operational Ambient Conditions: 32 to 120 degrees F.
 - 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
 - 9. Line voltage units UL recognized and CSA approved.
- B. Power Line Filtering:
 - 1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.

2.7 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units and operator station(s) over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 10 Mbps.
- E. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

- F. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.8 OPERATING SYSTEM SOFTWARE

- A. Input/Output Capability From Operator Station:
 - 1. Request display of current values or status in tabular or graphic format.
 - 2. Command selected equipment to specified state.
 - 3. Initiate logs and reports.
 - 4. Change analog limits.
 - 5. Add, delete, or change points within each control unit or application routine.
 - 6. Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.
 - 7. Add new control units to system.
 - 8. Modify and set up maintenance scheduling parameters.
 - 9. Develop, modify, delete or display full range of color graphic displays.
 - 10. Automatically archive select data even when running third party software.
 - 11. Provide capability to sort and extract data from archived files and to generate custom reports.
- B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.
- C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
 - 1. Add and delete points.
 - 2. Modify any point parameter.
 - 3. Change, add, or delete English language descriptors.
 - 4. Add, modify, or delete alarm limits.
 - 5. Add, modify, or delete points in start/stop programs, trend logs, etc.
 - 6. Create custom relationship between points.
 - 7. Create or modify DDC loops and parameters.
 - 8. Create or modify override parameters.
 - 9. Add, modify, and delete any applications program.
 - 10. Add, delete, develop, or modify dynamic color graphic displays.
- D. Dynamic Color Graphic Displays:
 - 1. Utilizes custom symbols or system supported library of symbols.
 - 2. Sixteen (16) colors, minimum.
 - 3. Sixty (60) outputs of real time, live dynamic data per graphic.
 - 4. Dynamic graphic data.
 - 5. 1,000 separate graphic pages, minimum.
 - 6. Modify graphic screen refresh rate between 1 and 60 seconds.
- E. Existing Operator Station:

1. Accept data from LAN as needed without scanning entire network for updated point data.
2. Interrogate LAN for updated point data when requested.
3. Allow operator command of devices.
4. Allow operator to place specific control units in or out of service.
5. Allow parameter editing of control units.
6. Store duplicate data base for every control unit and allow down loading while system is on line.
7. Control or modify specific programs.
8. Develop, store and modify dynamic color graphics.
9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.

F. Alarm Processing:

1. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Sequences of Operation and as designated by the User. Additional alarms can be added to all system points in the future without additional software, hardware or wiring, Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
2. Alarm Messages
 - a. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
3. Alarm Reactions
 - a. Operator shall be able to configure (by object) the actions that workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail and page notification, and audibly annunciate. The send e-mail alarm action should be able to run a report and attach it to the e-mail. The e-mail shall use SSL to secure the communications between the system server and the mail server.
 - b. Operator shall also be able to set the following conditions for an alarm action:
 - 1) Run the alarm action only when the alarm source generates an alarm or when it returns to normal.
 - 2) Wait a specified amount of time, then run the alarm action if the alarm has not been acknowledged or has not returned to normal.
 - 3) Run if the alarm occurs during the occupied hours defined for a schedule group, or run if the alarm occurs during the group's unoccupied hours.
4. Alarm Maintenance
 - a. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.

- H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.
- I. Messages:
 - 1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 - 2. Compose, change, or delete any message.
 - 3. Display or log any message at any time.
 - 4. Assign any message to any event.
- J. Reports:
 - 1. Manually requested with time and date.
 - 2. Long term data archiving to hard disk.
 - 3. Automatic directives to download to transportable media such as floppy diskettes for storage.
 - 4. Data selection methods to include data base search and manipulation.
 - 5. Data extraction with mathematical manipulation.
 - 6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
 - 7. Generating reports either normally at operator direction, or automatically under work station direction.
 - 8. Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.
 - 9. Include capability for statistical data manipulation and extraction.
 - 10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- L. Data Collection:
 - 1. The supplied system must incorporate the ability to access all data using browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) compliant web-server database is required for all system database parameter storage to allow all historical data to be easily imported into any ODBC compliant software (i.e. Microsoft ACCESS, EXCEL, etc.) This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
 - 2. Automatically collect and store in disk files.
 - 3. Provide archiving of stored data for use with system supplied custom reports.
- M. Trends:
 - 1. The contractor shall build graphic trends for the following for each HVAC system, with multiple trend points:
 - a. Analog outputs trend with output value, control input variable, setpoint value, reset value, modes, one trend per control loop.
 - b. Analog input trend with all input variables for a system.
 - c. Digital input/output trend with all digital variables for a system.

2. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object. Controller shall sample and store trend data and shall be able to archive data to the existing web-server. Owner shall be able to add additional trend points, intranet and internet viewable, and build trend graphs to display without additional hardware or software. Authorized operators shall have the capability of viewing trends from any workstation that is connected to the web.
- N. Graphic Display: Support graphic development on work station with software features:
1. Page linking.
 2. Generate, store, and retrieve library symbols.
 3. Single or double height characters.
 4. Sixty (60) dynamic points of data per graphic page.
 5. Pixel level resolution.
 6. Animated graphics for discrete points.
 7. Analog bar graphs.
 8. Display real time value of each input or output line diagram fashion.
- O. Maintenance Management:
1. Run time monitoring, per point.
 2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
 3. Equipment safety targets.
 4. Target point reset, per point.
- P. Advisories:
1. Summary which contains status of points in locked out condition.
 2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
 3. Report of power failure detection, time and date.
 4. Report of communication failure with operator device, field interface unit, point, programmable control unit.

2.9 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and SI (metric) units of measurement.
- B. Automatic Time Scheduling:
1. Self-contained programs for automatic Start/Stop/scheduling of Building HVAC loads.
 2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
 3. Special days schedule shall support up to 30 unique date/duration combinations.
 4. Any number of loads assigned to any time program; each load can have individual time program.
 5. Each load assigned at least 16 control actions per day with 1 minute resolution.
 6. Sequence starting of equipment with motors 3 KW or larger with adjustable time delay.

7. Minimum of 30 holiday periods up to 100 days in length may be specified for the year.
 8. Create temporary schedules.
 9. Broadcast temporary "special day" date and duration.
- C. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- D. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
 2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.
- E. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3600 seconds.
 2. Output may be analog value.
 3. Provide for "skip" logic.
 4. Verify completion of one action before proceeding to next. If not verified, program shall be able to skip to next action.
- F. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
1. Control loops: Defined using "modules" that are analogous to standard control devices.
 2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
 3. Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Lo signal selector.
 - f. Single pole double throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
 4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
 5. Display: Value or state of each of the lines which interconnect DDC modules.
- G. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:
 - a. Control loop being tuned
 - b. Input (process) variable
 - c. Output (control) variable
 - d. Setpoint of loop

- e. Proportional band
- f. Integral (reset) Interval
- g. Derivative (rate) Interval
2. Except from a start-up, maximum allowable variance from setpoint during functional testing for controlled variables shall be as follows:
 - a. Air temperature $\pm 1^{\circ}\text{F}$
 - b. Air humidity $\pm 5\% \text{ RH}$
 - c. Space temperature $\pm 0.5^{\circ}\text{F}$
 - d. Condenser water temperature $\pm 0.5^{\circ}\text{F}$
 - e. Heating water temperature $\pm 0.5^{\circ}\text{F}$
 - f. Duct pressure $\pm 0.2 \text{ inches w.g.}$
 - g. Water pressure $\pm 2 \text{ psid}$
3. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" vs "variable".

H. Trend logging:

1. Each control unit will store samples of control unit's data points.
2. Update file continuously at discretely assignable intervals.
3. Automatically initiate upload request and then store data on hard disk.
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
5. Co-ordinate sampling with on/off state of specified point.
6. Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.
7. The contractor shall assist the Owner in setting up the HVAC system trending functions during training. The specifications for the trends shall be defined by the Owner for identification by name, and recall by that name.

2.10 PROGRAMMING APPLICATION FEATURES

A. Trend Point:

1. Sample up to 6 points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month.
2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:

1. Allow definition of minimum of 50 messages, each having minimum length of 180 characters for each individual message.
2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
3. Output assigned alarm with "message requiring acknowledgments".
4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:

1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
2. Provide program times for each day of week, per point, with one minute resolution.
3. Automatically generate alarm output for points not responding to command.
4. Provide for holidays, minimum of 100 consecutive holidays.
5. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:

1. Permit events to occur, based on changing condition of one or more associated master points.
2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.

PART 3 EXECUTION

3.1 INSTALLERS

A. Installer List:

1. Frazier Service Company; Alex Brown (404) 456-7041.

3.2 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station.
- C. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.3 PROGRAMING

A. Include operating system programming of software capability specified to provide:

1. Set-up of system I/O capability, operator access as defined by the User, database creation and support.
2. Graphic Display-Levels: Provide graphic display leveling scheme for building site, floor plans, and system diagrams as follows:
 - a. Level 1: Identify location of building on the site.
 - b. Level 2: Show each floor plan of the building.
 - c. Level 3: Show each mechanical room and equipment layout.
 - d. Level 4: Show each individual system such as cooling tower water loop, heat pump condenser water loop, boiler heating water loop, DOAS units, exhaust systems, etc.
3. Graphic Display-Systems:
 - a. Provide and generate dynamic color graphics providing menu-generated flow charting of each building process using background graphics, standard and user defined symbols and dynamic variables.

- b. Provide flow charting for each system indicating all available points.
 - c. Indicate setpoint condition status by changing color, flashing. Provide flow charting for each system indicating all available points.
 - d. Dynamic updates: All graphic I/O object values shall update with change of value, or by operator selected discrete intervals.
4. Graphic Displays- Floor Plans:
 - a. Provide building floor plan graphics with thermographics or temperature readouts and a change in color during alarms.
 - b. Show actual locations of equipment, and thermostats on the graphics.
 5. Graphic Trends: - Each HVAC System:
 - a. Analog outputs trend with output value, control input variable, setpoint value, reset value, modes, one trend per control loop.
 - b. Analog input trend with all input variables for a system.
 - c. Digital input/output trend will all digital variables for a system.
 6. Sequences of Operation:
 - a. Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment.
 - b. Provide a link to the sequence of operation displays on their respective equipment graphics.
 7. Equipment Runtime monitoring.
- B. Include HVAC programming of software to provide:
1. System and equipment operating to specified Sequence of Operation.
 2. Start-stop Optimization.
 3. Night set-up/set-back of temperature set-points as directed by User.
- C. Include Load Control and Cooling Tower programming of software to provide:
1. Control functions of tower water temperature control.
 2. Tower basin sweep/filter activation On/Off.
- D. Include Load Control and Boiler heating loop programming of software to provide:
1. Boiler system enable/disable.
- E. Include Application system programming of software capability specified to provide:
1. Trend logging:
 - a. Logging, reporting and graphing of user defined system trends on disk file and printer as directed by user.
 - b. Organize data in each trend logs to facilitate documenting system operation in compliance with Sequence of Operation.
 2. Alarms: Logging, reporting and printing of user defined system alarms on disk file and printer as directed by user.
 3. Scheduling:
 - a. Program user defined system scheduling of HVAC systems as directed by the Owner.

3.4 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where accessible for inspection, maintenance and repair and not subject to excessive vibration.

- B. Terminal unit controllers shall be provided by controls vendor for factory installation by heat pump terminal device manufacturer.
- C. Install software in control units and in operator work station as required. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 0994.
- D. Modify existing software in control units and in operator work station. Add to existing capabilities as required to implement all features of programs to specified requirements and appropriate to sequence of operation.
- E. Identification:
 - 1. Nameplates: Identify all sensors mounted in mechanical rooms using device ID and number from control drawings with permanent label mounted adjacent to device. Nameplates shall be engraved plastic laminate with uppercase black letters on a white field, 1/4 inch minimum height.
 - a. Mounting: Attach nameplates with epoxy cement or non-ferrous screws after final painting.
 - 2. Conduit/Cable Markers:
 - a. Color coded, sunlight resistant cable ties.
 - b. Location: Install on all conduit and raceways exposed or above ceilings in a visible location at:
 - 1) Connections to junction, pull boxes, or manholes. Label box cover with nominal system voltage, circuit number and panel identification legibly written with permanent marker.
 - 2) Connections to equipment.
 - 3) Each side of a wall, roof or floor penetration.
 - 4) Along straight runs at 50 feet intervals.
 - 5) At changes of direction.
 - 6) Parallel Conduits: Group markers on each conduit in-line with the adjacent marker.
 - c. Color: Baby Blue.
 - 3. Color code cable with both ends identified with manufactured alpha-numeric self-adhesive vinyl tags, 3 mils thick, minimum, keyed to termination points.
- F. Communication Wiring:
 - 1. All wiring shall be in accordance with National Electrical Codes and Division 26 of this specification. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved. In addition all wiring jackets shall be labeled "BAS" in 3 foot or fewer intervals along the length of the jacket material.
 - 2. Contractor shall supply all communication wiring between Controllers, Routers, and other devices.
 - 3. Control LAN For any portions of this network required under this section of the specification, contractor shall use Category 5 or better cable as specified in TIA-568B. Media shall be Class 2 plenum rated and installed in accordance with manufacturer's recommendations. Network shall be run with no splices and separate from any wiring over thirty (30) volts.
- G. Signal Wiring:

1. Contractor shall run all signal wiring in accordance with National Electric Codes and Division 26 of this Specification.
 2. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire with PVC cover, Class 2 plenum rated. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
 3. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
- H. Low Voltage Analog Output Wiring:
1. Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 26 of this Specification.
 2. Low voltage control wiring shall be minimum 18-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.
- I. Electrical Wiring Installation:
1. All terminations of field wiring shall be to terminal strips.
 2. Power wiring to control units shown on drawings is provided under Division 26. Provide conduit and conductors and power supplies and transformers to extend power to all supplemental control units.
 3. Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 26 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
 4. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 26 of this Specification.
 5. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
 6. All control network wiring shield shall be terminated as recommended by controller manufacturer. All control network wiring shall be labeled with a network number, NodeID at each termination and shall correspond with the network architecture and floor plan submittals.
 7. Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Provide rigid conduit at all exterior locations and where subjected to moisture. All conduits penetrating partitions, walls or floors shall be sealed with an approved material to prevent migration of air through the conduit system and maintain the required firestopping performance. Communication wiring, signal wiring and low voltage control wiring may be run without conduit using plenum rated cable in concealed, accessible locations if noise immunity is ensured. Contractor will be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with

easy access. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be supported by piping, conduit, the ceiling or ductwork. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

- J. Provide conduit and electrical wiring in accordance with Section 26 2717. Electrical material and installation shall be in accordance with appropriate requirements of 26 0510.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide start-up certificate in the format prescribed by the General Conditions.

3.6 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. Provide services of control contractor's qualified technical personnel to instruct the Atlanta International School Facilities personnel in operation and maintenance of the controls system. Instruction shall be in classroom setting at the project site.
- B. Refer to Section 23 0510 - Demonstration, Training and Instructions for additional requirements.
- C. The standard operating manual for the control system and any special training manuals shall be provided for each trainee. Manuals shall include detailed descriptions of the subject matter for each training session. The manuals shall include system control sequences with a definitions index that fully describes relevant terms used in the manuals and in software displays.
- D. Training shall occur after the functional testing for the systems has been completed and systems are fully operational.
- E. Training shall be provided for up to 5 individuals.
- F. The Training Agenda shall include the following:
 - 1. Session 1:
 - a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of portable and built-in operator interface devices and display capabilities.
 - b. Brief overview of the various parts of the O&M manual, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.

- c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
 - d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
 2. Session 2:
 - a. General Review of sequence of operation, control unit programming, standalone modes, fail modes and graphic workstation screen for each HVAC subsystem.
 - b. Demonstration and set-up of alarm feature.
 - c. Demonstration and set-up of diagnostics features.
 - d. Demonstration of workstation graphic screens and functions.
 - e. Demonstration and set-up of trend feature.
 - f. Demonstration and set-up of workstation reports.
 - g. Fail modes and procedures to take in the event of and following a power outage.
 - h. Standalone modes and procedures to take in the event of and following various communication failures.
 - i. Question and answer period.
 3. Session 3:
 - a. Review of previous sessions.
 - b. Introduction to programming (utilize typical site specific programs) for all control unit types.
 - c. Demonstration of Control Unit features, diagnostics, program upload/download.
 - d. Demonstration of I/O hardware testing, calibration, and replacement.
 - e. Review of sequence of operation, control unit programming, standalone modes, fail modes and graphic workstation screen for each HVAC subsystem.
 - f. Demonstration of workstation diagnostics features, program upload/download capabilities and software backup concepts.
 - g. Question and answer period.
 4. Session 4:
 - a. Review of previous sessions.
 - b. Review of alarm, diagnostics, trends, graphics, and report features.
 - c. Review of fail modes and standalone modes and corresponding procedures to follow.
 - d. Review of I/O hardware testing, calibration, and replacement.
 - e. Start-up, Setpoint Adjustment, Scheduling and Shutdown Procedures for each system.
 - f. Demonstration of setpoint optimization and fine-tuning concepts.
 - g. Demonstration of control unit features, diagnostics, program upload /download.
 - h. Question and answer period.
 5. Session 5:
 - a. Review of previous sessions.
 - b. Review of all remaining miscellaneous workstation features.
 - c. Review of setpoint optimization and fine-tuning concepts.
 - d. Programming examples (utilize typical site specific programs) for all control unit types.
 - e. Demonstration of workstation diagnostics features, program upload/download capabilities and software backup concepts.
 - f. Question and answer period.

- G. Deferred Training, Testing, and Programming:
1. This session shall be conducted on-site approximately six months after occupancy for a minimum of 4 hours. Follow-up training shall be scheduled and structured to address specific topics and review questions concerning operation of the building automation system.
 2. Contractor shall provide 8 hours of control technician on-site support to verify programming and control loop tuning during off-season testing.
 3. Contractor shall provide 8 hours of control technician on-site support for reprogramming as directed by the Owner.

3.7 COMMISSIONING SUPPORT REQUIREMENTS:

- A. The Contractor shall attend a preliminary commissioning scoping meeting and other commissioning coordination meetings during the construction process as necessary to facilitate the commissioning process. Contractor is to keep the Commissioning Authority (CxA) and mechanical Commissioning Supervisor informed of progress with the Project and of changes to the proposed installation, programming and test plan.
- B. The Contractor shall provide assistance to the Commissioning Authority for scheduling and witnessing of testing. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.
- C. Preparation of a written start-up and initial checkout plan indicating in a step-by-step manner the procedures that will be followed to test, check-out, and adjust the control system prior to beginning functional testing. Submit the proposed plan to the Commissioning Authority and mechanical Commissioning Supervisor for review and approval prior to startup. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
1. Step-by-step procedures for testing each type controller after installation, including:
 - a. Process of verifying proper hardware and wiring installation.
 - b. Process of downloading programs to load controllers and verifying that they are addressed correctly.
 - c. Process of verifying proper hardware and wiring installation.
 - d. Process of performing operational checks of each controlled component.
 - e. Plan and process for calibrating valve and damper actuators and sensors.
 - f. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - g. A copy of the log and field check-out sheets that will document the process. This log shall include a place for initial and final values read during calibration of each point and clearly indicate when a sensor or controller has passed and is operating within the contract parameters. Notification of any equipment failures shall be documented.
 - h. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - i. A description of the instrumentation required for testing, including a certification of calibration for each test instrument.
 - j. Identify which tests and systems should be completed prior to using the control system for test, adjustment, and balance work.

- k. The Commissioning Agent may request further documentation necessary for the commissioning process.
2. Provide the Commissioning Authority and mechanical Commissioning Supervisor complete system logic diagrams, describing the proposed system programming, with programmed attributes shown. These diagrams shall be updated with field modifications from the start-up, check-out, and pre-functional testing prior to the beginning of the functional testing of the DDC system. Provide a copy of each proposed graphical interface screen with interface points shown for the entire system. Provide assistance to the Commissioning Authority in preparing the specific functional performance test procedures required, to include normal cut sheets and shop drawing submittals of commissioned equipment and any additional requested documentation, prior to normal O&M manual submittals. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
3. Pre-functional tests: Provide skilled technicians to execute startup of equipment and to execute the pre-initial checkout as described by the approved plan. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving. Verify and document the proper installation, addressing, calibration, programming, operation, and failure mode of DDC control points, sequences, and equipment and provide a copy to the commissioning authority. Provide a signed and dated certification to the Commissioning Authority and Commissioning Supervisor upon completion of the check-out of each controlled device, equipment, and system that installation, set-up, adjustment, calibration, and system programming is complete and as indicated on the Drawings, except functional testing. Completed pre-functional documentation of the system verification shall be submitted to the Commissioning Authority and Commissioning Supervisor for review and approval prior to the functional testing of the DDC control system or its being used in the testing of other equipment or systems, or other purposes. Copies of final field check-out sheets and trend logs shall be provided to the Commissioning Authority and Commissioning Supervisor for inclusion in the Commissioning Report.
4. Meet with the testing, adjusting, and balancing contractor prior to beginning the test, adjustment, and balance process and review the test, adjusting, and balancing plan to determine the capabilities and requirements of the control system in completing the testing, adjusting, and balancing process. For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the system completed and approved by the Commissioning Authority prior to beginning the testing, adjusting, and balancing effort. Provide the testing, adjusting, and balancing contractor with the appropriate software and any needed unique instruments for setting terminal units and instruct the testing, adjusting, and balancing contractor personnel in their use. Assist and cooperate with the testing, adjusting, and balancing contractor by providing a qualified technician to operate the controls as required to assist the testing, adjusting, and balancing contractor in performing his work, or alternatively, provide sufficient training for the testing, adjusting, and balancing contractor to operate the system without assistance. Verify the proper operation of affected controls at the completion of the test, adjustment, and balance procedure.
5. Address current Design Professional punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied

before functional testing of the control systems for the respective air- or water-related systems.

6. Functional tests: Conduct and document a functional test under the direction of the Commissioning Authority of the complete installed DDC control system. Functional testing is intended to begin upon completion of a system but may be conducted in phases or sections, as defined by the requirements of the Functional Test, or as approved by the Commissioning Authority. The DDC system, or applicable portions of the system, shall have completed pre-functional testing and be approved by the Commissioning Authority and Commissioning Supervisor before being used for other purposes, such as test and balance measurements, or in support of the functional testing of other systems.
 - a. Provide technicians and or knowledgeable programming personnel as required to conduct the required functional testing. Assist the Commissioning Authority in resolving issues found during the functional testing process.
 - b. Assist in the functional testing of equipment and systems by implementing trend logs and equipment monitoring as specified in the contract documents. The monitoring and data logging capabilities of the DDC system shall be available for use in the commissioning process. Assist the Commissioning Authority in the testing and documentation process by using the data logging and trending capability of the DDC system in monitoring the testing effort and recording the performance of systems and interpreting the monitoring data, as necessary.
 - c. The controls contractor shall coordinate with the University Facilities personnel and provide and set up a temporary testing operator station to allow full operator station interface with the system during the entire functional testing process. This temporary operator station shall provide all functions required of the system at the operator station, including real time graphic displays and report generation.
7. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Authority and retest the equipment.

D. Seasonal Adjustment:

1. Assist the Commissioning Authority and Commissioning Supervisor with the seasonal adjustment process. During this effort the Commissioning Authority and Commissioning Supervisor will:
 - a. Check and verify the calibration of temperature control devices and thermostats.
 - b. Test and verify control sequences for proper operation for the season.
 - c. Where deficient operation or defective equipment is discovered, provide corrective measures as required by the warranty provisions specified herein.

END OF SECTION 23 0923

SECTION 23 0994 - HVAC SEQUENCE OF OPERATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Submittal and Execution Requirements.
- B. Sequence of Operation for:
 - 1. Packaged DOAS Units
 - 2. Fans and Interlocks.
 - 3. Condenser Water Loop System.
 - 4. Cooling Tower Water Loop System.
 - 5. Boiler Heating Water Loop System.
 - 6. Fans and Fan Interlocks.
 - 7. Heating Terminal Units.
 - 8. Ductless Split System Air Conditioning Units.
 - 9. Water Source Heat Pump Units.

1.2 RELATED SECTIONS

- A. Section 23 0923 - Digital Control Equipment for HVAC.
- B. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits.
 - 2. Include written description of control sequence.
 - 3. Include flow diagrams for each control system, graphically depicting control logic.
- C. Review controls with and obtain approval of boiler manufacturer. Mark control diagrams "Approved" by boiler manufacturer.
- D. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS - NOT USED

END OF SECTION 23 0994

SECTION 23 2113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Condenser water piping, above ground.
- D. Tower water piping, above ground.
- E. Tower water piping, buried.
- F. Equipment drains and overflows.
- G. Pipe and pipe fittings for:
 - 1. Chilled water piping system.
 - 2. Equipment drains and overflows.
 - 3. Pipe hangers and supports.
 - 4. Unions, flanges, mechanical couplings, and dielectric connections.
- H. Valves:
 - 1. Gate valves.
 - 2. Ball valves.
 - 3. Butterfly valves.
 - 4. Check valves.
- I. Flow Indicator Balancers.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 23 0510 - General Mechanical Requirements- Pipe sleeves.
- D. Section 23 0548 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- E. Section 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.
- F. Section 23 0719 - HVAC PIPING INSULATION.
- G. Section 23 2114 - HYDRONIC SPECIALTIES.
- H. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- E. ASME B31.9 - Building Services Piping; 2014.
- F. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- H. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
- K. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- M. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2001 (Reapproved 2014).
- N. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings; 2005.
- O. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- P. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- Q. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; 2011 and errata.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
- S. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.
- T. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.

- U. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.
- V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- C. Provide non-conducting dielectric connections whenever jointing dissimilar metals.
- D. Fittings: Mitered Fittings and tapped pipes are not allowed. Weld elbows shall be long radius unless otherwise noted.
- E. Weldolets and Threadolets in Steel Piping: Weldolets and threadolets may be used for side outlet reducing tees if more than two pipe sizes smaller than main. Bonney Forge or Allied type 1 branchlet.
- F. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- G. Support piping independently from equipment.
- H. Provide butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- I. Provide ball, butterfly, or balance valves for throttling or manual flow control service (balance valve).
- J. Provide check valves on discharge of all pumps.
- K. Use butterfly valves in condenser water, tower water, and heating water piping 2-1/2 inch and larger water systems for throttling, bypass and isolation service (Refer to Flow diagrams and Details).
- L. Butterfly valves used to isolate equipment or to isolate lines where flanges will be removed shall be lug end.
- M. Drains: Provide 3/4 inch gate valves with gasketed cap with chain for drains at main shut off valves, low points of piping, bases of vertical risers, and at equipment.
- N. Air Vents: Provide manual or automatic air vents in accordance with Section 23 2114 at all high points in the piping and where shown.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME (BPV IX).
- D. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Joint Fittings: Submit manufacturer's material and installation brochure.
 - 5. Gaskets: Submit manufacturer's material brochure.
- E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- F. Shop Drawings: Refer to Section 23 0510 for piping shop drawing requirements.
- G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- H. Piping Tests - Submit the following:
 - 1. Hydrostatic Testing Records: The Contractor shall maintain a constantly updated log available to the Owner and Design Professional at all times. The Contractor shall submit a final log to the Owner and Design Professional for record.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum five years of experience.
- B. Welder Qualifications: Certify in accordance with ASME (BPV IX).

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept piping on site and inspect for cleanliness. Store in staging area in a protected location above grade.

- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage and store in a protected location.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Pipe-to-Equipment Connections: Use unions or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

2.2 BOILER HEATING WATER PIPING, ABOVE GRADE

- A. Distribution piping 2-1/2 inch and larger shall be steel pipe.
- B. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.
 - 2. Threaded Joints: ASTM B 16.3, malleable iron fittings.
 - 3. Joints:
 - a. Pipe sizes 2 inch and smaller: Threaded.
 - b. Pipe sizes 2-1/2 inch & larger: Welded.

2.3 CONDENSER WATER PIPING, ABOVE GROUND

- A. Floor distribution piping 1-1/2 inch and smaller and all Runouts to terminal equipment shall be copper tube.
- B. Distribution piping 2 inch and larger shall be steel pipe.
- C. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black; using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1 welded.
 - 2. Threaded Joints: ASTM B 16.3, malleable iron fittings.
 - 3. Joints:
 - a. Pipe sizes 2 inch and smaller: Threaded.
 - b. Pipe sizes 2-1/2 inch & larger and all concealed above non-accessible ceilings: AWS D1.1, welded.

- D. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn, using the following joints and fittings:
1. Fittings: Solder type ASME B16.18 cast/bronze/brass or ASME B16.22 wrought copper fittings, unless otherwise noted.
 2. Joints:
 - a. Coil connections, and within equipment cabinets:
 - 1) Soldered ASTM B32 lead and antimony free solder, 96 Sn/4 Ag (tin-silver) alloy with zinc fluoride flux.
 - 2) Typical product is Harris Product Group 'Stay -Brite' with 'Staya-Clean' flux.
 - b. Couplings, Tees and elbows in piping mains and branches:
 - 1) Brazed. AWS A5.8/A5.8M BuCP copper/silver/phosphorous alloy, minimum 1485 degree F liquidus.
 - 2) Solder shall be rated for recommended joint clearance of 0.002" to 0.006".
 - 3) Silver content shall be 5-15%, except 6% silver alloys are not acceptable.
 - 4) Typical products are Harris Product Group 'Stay-Silv 15', 'Stay Silv 5' and 'Dynaflow'.

2.4 TOWER WATER PIPING, ABOVE GROUND

- A. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or ASTM D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.
- B. PVC Pipe Sizes 8 Inch and Larger: ASTM D1785, Schedule 80, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or ASTM D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.

2.5 CONDENSER WATER PIPING, BURIED

- A. Piping shall be schedule 40 welded black steel piping, corrosion coated with a layer of adhesive and extruded black high density polyethylene(HDPE), minimum 100 mils thick. Fittings shall be wrapped with heat shrink tape. Thermacor (or similar) HDPE Jacketed Piping. Ductile Iron Pipe:
1. Ductile Iron Mechanical Joint Pipe, Flexible Restrained: AWWA C151/A21.51, with working pressure of 350 psi.
 2. Fittings: AWWA C110, ductile iron, standard thickness.

2.6 UNDERGROUND WARNING TAPE

- A. Manufacturers:
1. Brady Identoline
 2. Seton 210
 3. Water Works Ind, Inc.
- B. Detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape for warning and identification of buried piping. Tape shall be detectable by an electronic

detection instrument. Provide tape in minimum 4-inch width rolls, color coded for the utility involved, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

- C. Warning tape shall read "CAUTION - BURIED PIPING BELOW" or similar wording at minimum 18-inch intervals.

2.7 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A 53/A 53M, Schedule 40 galvanized; using one of the following joint types: Unless noted otherwise.
 - 1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy 96 Sn/4 Ag (tin - silver.)

2.8 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Manufacturers: B-Line, Grinnell, Globe or Michigan. Figure numbers are for Michigan.
- C. Conform to ASME B31.9.
- D. Hangers Sizes 1/2 to 3/4 Inch: Carbon steel, adjustable swivel, loop. Figure 100.
- E. Hangers Sized for Cold Pipe 1 Inch and Over: Carbon steel, adjustable, clevis. Figure 400.
- F. Hangers for Hot Pipe Sizes 1 to 4 Inches: Carbon steel, adjustable, clevis. Figure 400.
- G. Multiple or Trapeze Hangers(Up to 2 inch pipe size): Green epoxy coated, cold formed, lipped steel channels, sized for pipe load and span, 1-5/8" x 1-5/8" x 12 gauge minimum, with pipe/tubing clamps, elastomer cushion, spring held, hardened steel nuts and hanger rods.
- H. Multiple or Trapeze Hangers(Over 2 inch pipe size): Steel channels with welded spacers and hanger rods.
- I. Wall Support for Single Pipe Sizes to 3 Inches: Carbon steel extension split ring pipe clamp, Figure 455.
- J. Wall Support for Vertical Multiple Pipes(1-1/2 inch and under: Green epoxy coated, cold formed, lipped steel channel horizontal member, 1-5/8" x 1-5/8" x 12 gauge base. Secure pipes to base with pipe/tubing clamps and elastomer cushion.

- K. Wall Support for Pipe Sizes 4 Inches and Over: Heavy duty, Welded carbon steel bracket and wrought steel clamp, Figure 353.
- L. Vertical Support: Steel riser clamp, Figure 510.
- M. Floor Support for Piping (Pipe Stanchion): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support from floor.
- N. Copper Pipe Support: As Specified above, copper plated where tube is not insulated.
- O. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- P. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.9 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Under:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: 400 psig WOG @ 275 degrees F, Brass O-Ring type with EPDM O-Ring , brass nut and tailpiece. Threaded or soldered with reduced size end connection as required by component connection. Apollo UA, FDI UP
 - 3. Test Plug tapings may be included on union tailpieces to provide the test plugs specified at piping components.
- B. Flanges for Pipe Over 2 Inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on, unless noted otherwise.
 - 2. Gaskets: 1/16 inch thick composition sheet type gasket with aramid fiber and NBR binder. Gasket material shall be asbestos-free conforming to ASTM B16.5-2013, selected for the pressure, temperature, and service of the specific joint. Garlock BLUE-GARD 3000, TEADIT NA1001, or similar.

2.10 GATE VALVES

- A. Up To and Including 2 Inches:
 - 1. Manufacturers: Crane Model 438, Hammond IB 645, Milwaukee 105, Nibco T113, Stockham B103.
 - 2. 200 psig WOG, bronze body, bronze trim, screwed bonnet, non-rising stem, cast or malleable iron handwheel, inside screw with backseating stem, solid wedge disc, alloy seat rings, threaded ends.
- B. Over 2 Inches:
 - 1. Manufacturers: Crane Model 461, Hammond IR 1138HI, Milwaukee F 2882-M, Nibco F619, Stockham G612.
 - 2. 200 psig WOG, iron body, bronze trim, bolted bonnet, non-rising stem, cast or malleable iron handwheel, solid wedge disc with bronze seat rings, flanged ends.

2.11 BALL VALVES

- A. Up To and Including 2 Inches:
 - 1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
 - 2. Two Piece Manufacturers: Crane 9301, Flow Design HB/HC, Hammond 8201, Milwaukee BA200, Nibco T580, Stockham T255.
 - 3. 400 psig WOG, Bronze two piece body, full port, chrome plated brass ball, reinforced teflon seats and stuffing box ring, blow-out proof stem design, adjustable packing gland, zinc coated steel lever handle with vinyl hand grip with memory stops on balance valves, threaded ends .

2.12 BUTTERFLY VALVES (PVC over 2 inches)

- A. Layout Basis: Nibco Model C.
- B. Other Acceptable Manufacturers: Centerline, Crane, Flow Design BF, Grinnell, Hammond, Milwaukee, Mueller, Stockham.
- C. Location: Use where specifically shown on Drawings, Detail or Flow Diagram. Refer to Legend for butterfly valve symbol.
- D. Body: PVC with resilient replaceable seat with EPDM molded over a brass disc, hardened 416 stainless steel shafts, wafer or lug ends with built-in O-ring face -seals, extended neck.
- E. Disc: Brass encapsulated with EPDM.
- F. Operator: 10 position lever handle.

2.13 BUTTERFLY VALVES (Over 2 inches)

- A. Manufacturers: Crane 12, Hammond 5111, Milwaukee WA, Mueller 66M, Nibco WD-2000-3, Pratt BFStockham LG551.
- B. Location: Use where specifically shown on Drawings, Detail or Flow Diagram. Refer to Legend for butterfly valve symbol.
- C. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- D. Disc: Aluminum bronze.
- E. Operator: Handwheel and gear drive.

2.14 SPRING LOADED CHECK VALVES (OVER 2 inch)

- A. Manufacturers: Centerline Model CLC, Duo-Check G12HMP, Hammond IR9253, Marlin HZNSF, Metraflex 700, Milwaukee 1400, Muessco 91AP/92AP, Stockham WG970..

- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.15 FLOW INDICATOR-BALANCERS (CIRCUIT SETTER)

- A. Manufacturers: B&G Circuit Setter, AAF #6000, Taco ACUF, Illinois #6000, Flow Set - F, HCi Terminator, Florater, Gerand, ProHydronic Specialties "CBV", Wheatley "BV".
- B. Balancer (1/2" - 2"): Calibrated bronze screwed balance valve with indicating pointer, memory stop, stainless steel ball, and with pressure taps for connecting differential pressure meter. Pressure taps shall be equipped with caps and integral check valves. Each valve shall have preformed, removable insulation cover. Locate to provide unrestricted flow up and down-stream in accordance with manufacturer's recommendations.
- C. Balancer (2-1/2" - 12"): Calibrated cast iron ball or globe style balance valve with flanged connections, indicating pointer, memory stop, and with pressure taps for connecting differential pressure meter. Pressure taps shall be equipped with caps and integral check valves. Each valve shall have preformed, removable insulation cover. Locate to provide unrestricted flow up and down-stream in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment using jointing system specified.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Section 23 2500 for additional requirements.
- F. Connections to existing systems: Exact location of piping, direction of flow and fluid being handled shall be confirmed by the Contractor prior to installing new piping to assure compatibility of system, fluid being pumped, and pipe sizes

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. PVC Pipe for Condenser Water Service: Provide PVC piping at cooling tower only where noted on the drawings. Make solvent-welded joints in accordance with ASTM D2855.

- C. Route piping in orderly manner, parallel to building structure, and maintain plumb and level, unless noted otherwise.
- D. Maintain 4 inch clearance between pipe and fittings after insulation.
- E. Install piping to conserve building space and to avoid interfere with use of space.
- F. Group piping at common elevations.
- G. Sleeve pipe passing through new masonry partitions, walls and floors. Provide sleeves at rated partitions as required by firestopping assembly.
- H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8413.
- I. Maintain top of piping level with eccentric reducers. Arrange to drain at low points.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- K. Install valves and piping appurtenances in a readily accessible location.
- L. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- M. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 24 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser and wall supported piping independently of connected horizontal piping and at spacing indicated in schedule.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Use double nuts and lock washers on threaded rod supports.
 - 9. Provide copper plated hangers and supports for copper piping where hanger is in contact with tubing.
 - 10. Prime coat concealed steel hangers and supports not provided with a corrosion resistant finish. Refer to Section 09 9000.

11. Support piping from floor only where shown on drawings or where piping is routed along floor.
12. Upper attachments:
 - a. Provide attachment to upper cord of bar joist or to flanges of steel beams. Attach with beam clamps or other listed devices for this purpose.
 - b. Do not support from roof deck.
 - c. Weights of 15 Lbs. or less may be supported from floor decks.
 - d. Unless otherwise noted, connect pipe supports to structural members only. Where structural members do not occur above piping, provide supports spanning between members. Supports shall be sized for weight to be supported.
- N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- O. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.
- P. Use eccentric reducers to maintain top of pipe level.
- Q. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- R. Prepare exposed unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- S. Install valves and pipe appurtenances in a readily accessible location.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Unions: Provide unions at locations specified and at all locations to permit removal of equipment and ATC control valves for service. Install in correct direction with brass nut upstream. Do not install unions to expedite pipe assembly. Use flanges for unions for pipes sizes over 2 inch.
- V. Dissimilar Metals (Dielectric): Provide dielectric nipples to provide separation between ferrous and nonferrous piping/fittings. Install on ferrous side of connection. Do not install dielectric unions. Dielectric connection shall be comprised of dielectric nipple or thread-to-sweat brass adapter or brass valve. Install unions specified with dielectric nipple where separation is required at a union.
- W. Steel Pipe Nipples: All thread (close) nipples are prohibited. Nipples 1-1/2 inch and smaller and attached to larger pipes shall be schedule 80 and attached by the use of threadolets.
- X. Hydronic Differential Pressure sensors: Orient pipe tapings on side of pipe. Do not connect to top or bottom of pipe.

3.3 PIPE AND FITTINGS BELOW GRADE

A. General

1. Inspect, test, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections.
 2. All pipe shall be accurately cut to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation shall not be permitted. Pipe shall be installed to permit free expansion and contraction without damage to joints.
 3. Make changes in piping sizes through tapered reducing pipe fittings.
- B. Utility Warning Tape: Bury tape with the painted side up at a depth of 18 inches above top of piping.

3.4 SCHEDULES

- A. Hanger spacing indicated is maximum span based on pipe material and size. Conform to structural spacing and load capacity of structural support points and provide closer spacing as required.
- B. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- C. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
- D. Hanger Spacing for Plastic Piping.
1. 4 inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.
 2. 6 inches: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 3. 8 inches: Maximum span, 11 feet; minimum rod size, 5/8 inch.

END OF SECTION 23 2113

SECTION 23 2114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Expansion tanks.
- B. Expansion tanks.
- C. Make-up water station.
- D. Air vents.
- E. Air separators.
- F. Strainers.
- G. Pump suction diffuser fittings.
- H. Automatic flow control valves.
- I. Flow indicators and meters.
- J. Radiator valves.
- K. Relief valves.
- L. Glycol system.

1.2 RELATED REQUIREMENTS

- A. Section 23 2113 - HYDRONIC PIPING.
- B. Section 23 2500 - HVAC Water Treatment: Pipe Cleaning.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Provide Certificate of Glycol Systems testing and Start-up.
- E. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on specialties. Maintain in place until installation.
- C. Protect from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 DIAPHRAGM TYPE EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol AX or L Series.
 - 2. Other acceptable manufacturers offering equivalent products.
 - a. Armstrong AX or L Series.
 - b. Bell & Gossett.
 - c. Patterson
 - d. Wheatley BDT.
 - e. Wessels NTA or NLAP
- B. Construction- Less than 60 gallons: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible butyl diaphragm sealed into tank, and steel support stand.
- C. Construction-60 gallons and over: Welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); supplied with National Board Form U-1, rated for working pressure of 125 psi, with replaceable, flexible butyl bladder, and steel support stand.
- D. Accessories:
 - 1. Pressure gage and air-charging fitting.
 - 2. Tank Purge Valve: Provide combination ball type isolation valve with accessory tappings. Valve is tapped with two test plugs and a 5/8" with drain valve with 5/8 inch hose end connection. B&G TPV.
 - 3. Tank drain for replaceable diaphragm tanks.
- E. Charge tank to pressure indicated on Drawings.
- F. Provide factory enamel finish on tanks.

2.2 MAKE-UP WATER STATION

- A. Pressure reducing valve, backflow preventer, test cocks, strainer, Gauge, and valved by-pass, Refer to Detail on Drawings.
- B. Pressure Reducing Valve: 300 PSIG maximum working pressure at 160 degrees F maximum operating temperature. Bronze pressure reducing valve for dead-end service with NPT union inlet and NPT female outlet for standard (25-75 PSIG) or low (10-35 PSIG) reduced pressure range as shown on drawings. Watts U5B.
- C. Backflow Preventer: ASSE Std 1013, 175 PSIG maximum working pressure Bronze Reduced Pressure type with built-in air gap, air gap fitting, test cocks and isolation ball valves. Manufacturers: Watts 009, Conbraco Series 40-200, Febco Series 825Y, Hersey Series FRP-11, or Wilkins Series 975XLS

2.3 AIR VENTS

- A. Manual Type:
 - 1. Pipe Sizes up to 2 inches: Short vertical sections of pipe to form air chamber, same size as pipe, with 1/2 inch brass ball or gate valve at top of chamber.
 - 2. Pipe Sizes 2-1/2 inches and over. Short vertical sections of 2-1/2 inch diameter pipe to form air chamber, with 1/2 inch brass ball or gate valve at top of chamber.
 - 3. Equipment Rooms: Terminate discharge along wall with valve and hose end connection in an accessible location. Refer to detail on drawings.
- B. Automatic Float Type:
 - 1. Manufacturers: Amtrol 706, Armstrong 75, Hoffman 79, Wheatley 79, Watts 4VA.
 - 2. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.4 AIR SEPARATORS

- A. Tangential Air Separator
 - 1. Manufacturers:
 - a. Armstrong International, Inc; Model VAS: www.armstronginternational.com/#sle.
 - b. ITT Bell & Gossett; Model Rolairtrol: www.bellgossett.com/#sle.
 - c. Patterson.
 - d. Taco, Inc; Model AC: www.taco-hvac.com/#sle.
 - e. Wheatley Model TAS.
 - 2. Steel tank, tested and stamped in accordance with ASME (BPV VIII, 1); for 125 psi operating pressure, sized for pipe line size without integral strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.

2.5 STRAINERS

- A. Size 2 inch and Under:

1. Manufacturers: Armstrong, Conbraco, Crane, Flow Design YC/YW, Hoffman, Keckley, Leslie, Metraflex, Mueller, McAlear, Sarco, Watts, Wheatley.
 2. Copper Piping System: Screwed, cast or forged brass body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen and removable cap with blowdown tapping.
 3. Steel Piping System: Screwed, cast iron or forged steel body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen and removable cap with blowdown tapping.
 4. Strainers shall be provided with a ball type blow-down valve with hose-end connection with gasketed cap with chain.
- B. Size 2-1/2 inch to 4 inch:
1. Manufacturers: Armstrong, Conbraco, Crane, Hoffman, Keckley, Leslie, Metraflex, Mueller, Sarco, Wheatley.
 2. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen for closed piping system duty and 1/8 inch for open piping system duty. Provide blowdown tapping.
 3. Strainers shall be provided with a ball type blow-down valve with hose-end connection with gasketed cap with chain.
- C. Size 6 inch and Larger: (Tower Water Pump Service)
1. Provide flanged iron body for 175 psi working pressure, basket pattern with clamped cover top access, 1/8 inch stainless steel perforated screen.
 2. Provide tapped and plugged bottom drain connection.
 3. Install full size ball type blowdown valve in drain piping and extend to nearest floor drain.
 4. Manufacturers: Mueller 155M. Other Manufacturers: Armstrong, Conbraco, Crane, Hoffman, Keckley, Leslie, Metraflex, Sarco, Wheatley.

2.6 PUMP SUCTION DIFFUSER FITTINGS

- A. Manufacturers:
1. Armstrong SG.
 2. ITT Bell & Gossett; Model Z: www.bellgossett.com/#sle.
 3. Mueller 1011.
 4. Patterson SD.
 5. Weatley SO.
 6. Taco SD
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure and sized for pump and system connections, with stainless steel inlet vanes, stainless steel cylinder strainer arranged for horizontal removal, disposable fine mesh start-up strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- C. Cylinder strainer with 3/16 inch diameter openings for closed piping systems.
- D. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.7 AUTOMATIC FLOW CONTROL VALVES

- A. Manufacturers: IMI Flow Design-AutoFlow, Griswold.
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet. Flow cartridge shall be removable from the valve body to provide access for regulator changeout, inspection, and cleaning. Valves shall be pressure rated for 400 PSIG at 250 F.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 2-32 psig, maximum pressure loss of 3.5 psi across the valve.
- D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Unit body shall have two pressure tappings with a factory, non-ferrous tag giving valve station number, flow rate, valve model.

2.8 RADIATOR VALVES

- A. Angle or straight pattern, rising stem, inside screw globe valve for 125 psi working pressure, with bronze body and integral union for screwed connections, renewable composition disc, plastic wheel handle for shut-off service, and lockshield key cap and set screw memory bonnet for balancing service.

2.9 RELIEF VALVES

- A. Manufacturers:
 - 1. Watts Model 3L; 174A.
 - 2. Other acceptable manufacturers offering equivalent products: Armstrong, Bell & Gossett, Hoffman, Kunkle, Spence.
- B. Bronze body, teflon seat, stainless steel stem and springs and test lever, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.10 GLYCOL SYSTEM

- A. Glycol Make-Up Unit
 - 1. Manufacturers:
 - a. Bell and Gossett; Model GMU-*: www.bellgossett.com
 - b. Neptune Chemical Pump Company; Model G-*: www.neptune1.com
 - c. Wessels Co.; Model GMP: www.westank.com
 - 2. Packaged glycol make-up system with solution tank, tank stand, fill pump, controls and control panel.
 - 3. Solution Tank
 - a. 50 gallon capacity, minimum, polyethylene, self-supporting, 5 gallon graduated markings; molded fiberglass cover with metal stand and low level liquid level switch.

- b. Spill Containment: Provide a rectangular polyethylene containment basin to provide a minimum 110% containment volume of the solution tank.
4. Fill Pump, Piping and Appurtenances
 - a. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and relief valve.
 - b. Provide interconnecting piping of
 - c. Provide service valve(ball) and Y-strainer on pump suction. Provide service valve, check valve and discharge pressure gauge on pump discharge.
 - d. Electrical Characteristics:
 - 1) 120 volts, single phase, 60 Hz.
 - 2) Cord and Plug: Provide unit with 6 foot cord and plug for connection to electric wiring system including grounding connector.
5. Control Cabinet:
 - a. NEMA 4X enclosure, UL listed, with grounding lug, terminal strip, and fusible control circuit transformer.
 - b. Magnetic starters with overload relays, circuit breakers and cover interlock.
 - c. HOA switch for pump motor.
 - d. Pump ON indicator.
 - e. Pressure switch and controls to maintain system setpoint pressure as indicated on drawings.
 - f. Solution tank low level sensor.
 - g. Dry contact for remote low level indication.
6. Mixing Tank: 55 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
7. Storage Tank: Closed type, welded steel constructed, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tapings for installation of accessories.
8. Expansion Tank: Diaphragm type with vent fitting with air separator, and automatic air vent.
9. Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve and needle valve bypass.
10. Pump Low Water Cutoff:(LWCO): McDonnell-Miller #63M low water cut-off rated for 50 psi working pressure to prevent pump operation when water falls below safe level.
11. Fill funnel: Welded steel construction with 5" diameter funnel , cleaned and prime coated. Grind all welds smooth.
12. Glycol Solution:
 - a. Inhibited propylene glycol and water solution mixed 30 percent glycol - 70 percent water, suitable for operating temperatures from 5 degrees F to 250 degrees F. Refer to 23 2500.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Install specialties in a readily accessible location.

- C. Adjust pressure reducing valve for initial fill pressure indicated on Drawings.
- D. Adjust diaphragm tank air pressure for initial fill pressure indicated on Drawings prior to filling system.
- E. Provide manual air vents at system high points and as indicated.
- F. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- G. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- H. Provide valved drain and hose connection on strainer blow down connection.
- I. Provide pump suction diffuser fitting on suction side of all base mounted end-suction centrifugal pumps.
- J. Remove temporary strainers after cleaning systems and approximately 60 hours operating time. Tie to pump fitting without cleaning for removal after observation.
- K. Support pump fittings with floor mounted pipe and flange supports.
- L. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- M. Pipe relief valve outlet to floor. End of pipe or fitting shall not be threaded.
- N. Feed glycol solution to system through make-up line with pumped fill system, venting system high points.
- O. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION 23 2114

SECTION 23 2123 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vertical in-line pumps.
- B. Base mounted, vertical, single stage, split case pumps.
- C. Base mounted, end suction pumps.

1.2 RELATED REQUIREMENTS

- A. Section 018000 - Cx Process.
- B. Section 01 8010 - Cx Pre-functional Checklists.
- C. Section 01 8020 - Cx Functional Performance Testing.
- D. Section 03 3000 - Cast-in-Place Concrete.
- E. Section 23 0513 - MOTORS FOR HVAC EQUIPMENT.
- F. Section 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.
- G. Section 23 0716 - HVAC EQUIPMENT INSULATION.
- H. Section 23 0719 - HVAC PIPING INSULATION.
- I. Section 23 2113 - HYDRONIC PIPING.
- J. Section 23 2114 - HYDRONIC SPECIALTIES.
- K. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. NEMA MG 1 - Motors and Generators; 2014.
- B. NFPA 70 - National Electrical Code, 2014 Edition; National Fire Protection Association

1.4 PERFORMANCE REQUIREMENTS

- A. All pumps shall operate at 1750 RPM unless noted otherwise.
- B. Pump motors shall not overload at any point on the pump curve.

- C. Impeller diameter shall not exceed 85% of casing accommodation as measured from pump cut water through centerline of shaft.
- D. For a pump installed in parallel with another pump, in the event that one pump is off line, the other pump shall be capable of providing 150% of the specified flow at 2/3 of the specified pump head.
- E. Pump characteristic curve shall rise continuously from maximum capacity to shut-off with shut-off head a minimum 10% greater than design head.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Submit all items in the fluid stream with or prior to pump submittals.
- C. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- D. System profile analysis including pump curves, system curve, and variable speed pump curves (where applicable).
- E. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- F. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- G. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- H. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL 778 as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept pump materials on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. All scratched, and otherwise damaged units shall be repaired or replaced by the Construction Manager.

PART 2 PRODUCTS

2.1 VERTICAL IN-LINE PUMPS (VIL)

- A. Manufacturers: Armstrong 4360, B&G Series 80, Patterson VIL, Taco KV.
- B. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi working pressure.
- C. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- E. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- F. Seal: Carbon rotating against a stationary ceramic seat, viton fitted, 275 degrees F maximum continuous operating temperature.
- G. Each pump shall be hydrostatically tested and painted with one coat of high quality factory approved paint and name-plated before shipment from the factory.
- H. Motor: 1750 rpm unless specified otherwise; refer to Section 23 0513.
- I. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.2 BASE MOUNTED END SUCTION PUMPS (ES)

- A. Manufacturers:
 - 1. Armstrong; Model 4030: www.armstrongpumps.com
 - 2. Bell and Gossett; Model e-1510: www.bellgossett.com
 - 3. Patterson; Model HVES: www.pattersonpumps.com
 - 4. Taco; Model FI: www.taco-hvac.com
- B. Type: Horizontal shaft, single stage, direct connected, radially split casing, for 125 psi maximum working pressure.
- C. Casing: Casing shall be minimum Class 35 cast iron and provided with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug(s) at the low point(s), vent(s) at the high point(s), flanged suction and discharge.
- D. Impeller: Impeller shall be centrifugal, fully enclosed, non-overloading, bronze and keyed to shaft with a guide ring and mechanical seal.

- E. Bearings: Bearings shall be Grease lubricated steel roller or ball bearings. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end. Pump bearings shall be regreaseable without removal of the bearings from the bearing assembly.
- F. Shaft: Shaft shall be SAE 1144 steel with a #304 stainless steel shaft sleeve.
- G. Seal: Mechanical seal(s) shall be carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.
- H. Coupling: Pump and motor shall be direct connected through Woods Standard Sureflex flexible coupling with coupling guard mounted on a common metal base.
- I. Base plate shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI-2009 for grouted Horizontal Baseplate Design standards.
- J. Bases for pumps handling chilled water shall be provided with a stainless steel drain pan extending under the suction diffuser and 1/2-inch tapped drainage opening.
- K. Each pump shall be hydrostatically tested and painted with one coat of high quality factory approved paint and name-plated before shipment from the factory.
- L. Motor: 1750 rpm unless specified otherwise. Motors for outdoor pump applications shall be totally enclosed type with weather protection. Refer to Section 23 0513.

2.3 BASE MOUNTED, DOUBLE SUCTION, SINGLE STAGE, VERTICAL SPLIT CASE PUMPS (VSC)

- A. Manufacturers:
 - 1. Bell & Gossett VSX - Model VSCS; www.bellgossett.com
 - 2. Taco - Model TS; www.taco-hvac.com
- B. Type: Horizontal shaft, single stage, direct connected, vertical split design, 125 psi maximum working pressure.
- C. Casing: Casing shall be minimum Class 35 cast iron and provided with integrally cast support feet, suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug(s) at the low point(s), vent(s) at the high point(s), flanged suction and discharge.
- D. Impeller: Impeller shall be centrifugal, fully enclosed double suction type, non-overloading, bronze and keyed to shaft with a guide ring and mechanical seal. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines.
- E. Bearings: Bearings shall be Permanently lubricated roller or ball bearings.
- F. Shaft: Shaft shall be SAE 1144 stainless steel with a stainless steel shaft sleeve.

- G. Seal: Mechanical seal(s) shall be carbon rotating against a stationary ceramic seat, 225 degrees F maximum continuous operating temperature.
- H. Coupling: Pump and motor shall be direct connected through Woods Standard Sureflex flexible coupling with coupling guard mounted on a common metal base.
- I. Base plate shall be welded structural steel fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI-2009, for Horizontal Base Plate Design standards.
- J. Bases for pumps handling chilled water shall be provided with a stainless steel drain pan extending under the volute and 1/2-inch tapped drainage opening.
- K. Each pump shall be hydrostatically tested and painted with one coat of high quality factory approved paint and name-plated before shipment from the factory.
- L. Motor: 1750 rpm unless specified otherwise; refer to Section 23 0513.
- M. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Provide line sized shut-off valve and pump suction fitting or strainer as detailed on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- D. Provide drains for bases, piped to and discharging into floor drains.
- E. Install base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout pump base in place after alignment. Refer to Section 03 3000.
- F. Check, align, and certify alignment of base mounted pumps after pump leveling, after piping connections are made, and again after operation of the system for a three (3) week continuous period of time.
- G. Install pressure gauge on each base mounted pump as detailed. Gauge piping shall be copper tubing extended from pump tappings.
- H. Lubricate pumps before start-up.

3.3 STARTING EQUIPMENT

- A. Start no equipment or systems until all prefunctional checklists have been completed, signed, and sent to the CxA for approval.
- B. Provide manufacturer's field representative to prepare and start equipment.
- C. Adjust for proper operation within manufacturer's published tolerances.
- D. Provide start-up certificate in the format prescribed by the General Conditions.

3.4 COMMISSIONING TESTS

- A. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.
- B. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation and maintenance of equipment to the Owner's designated representatives.
- B. Provide the services of the manufacturer's field representative to conduct training.

3.6 SCHEDULES

- A. Refer to Pump Schedule on Drawings.

END OF SECTION 23 2123

SECTION 23 2140 - UNDERGROUND HYDRONIC DISTRIBUTION SYSTEMS-STEEL PIPE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe and pipe fittings for:
 - 1. Underground condenser water piping distribution system.
- B. Underground Warning Tape.
- C. Valves for Underground piping distribution system.
- D. Testing Requirements.

1.2 SCOPE OF WORK

- A. The Contractor shall provide all labor, equipment, materials and incidentals necessary to install the underground condenser water distribution systems. These systems include but are not limited to factory fabricated conduit piping, equipment room entry, utility trench construction, piping supports, fittings, and accessories. These systems shall be installed and tested as shown on the Contract Drawings and as specified herein.

1.3 RELATED SECTIONS

- A. Section 23 2500 - HVAC Water Treatment: Pipe flushing and cleaning.
- B. Division 31 0000: Earthwork

1.4 REFERENCES

- A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2001.
- B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998.
- C. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; 2007 (ANSI/ASME B31.1).
- D. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2001.
- E. ASTM A 234/A 234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2001a.

- F. ASTM D 698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 1991.
- G. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 1990 (Reapproved 1996).
- H. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2010.

1.5 DEFINITIONS

- A. In ANSI B31.3, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should" wherever it appears.

1.6 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements, for submittal procedures.
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information.
 - 1. Gaskets: Submit gasket manufacturer's brochure.
 - 2. Studs and Nuts: Submit manufacturer's material brochure showing conformance to the requirements of ASTM A-193 and ASTM A-194 or a letter from the manufacturer certifying conformance to ASTM requirements.
 - 3. Welding Fittings: Submit manufacturer's material brochures showing conformance to the requirements of ASTM A-234, ANSI B16.5, ANSI B16.9, and ANSI B16.11 or a letter from the manufacturer certifying conformance to ASTM and ANSI requirements.
- C. Shop Drawing Submittals, Approval of Materials and Proposed Schedule of Activities:
 - 1. Submit shop drawings, material certification and schedule of work activities.
 - 2. The shop drawings shall include a submittal with analysis of pipe expansion in accordance with ASME/ANSI B31.1 Code for Pressure Piping. Means for piping expansion must be provided in offsets and loops.
 - 3. The shop drawings shall include piping layout with locations of anchors, expansion loops, valve stations, and building entry details. Indicate pipe materials used, jointing methods, building floor and wall penetration seals. Indicate installation, layout, dimensions, expansion, bolstering and piping connections.
- D. Welding Quality Control:
 - 1. Welding Procedures Specification (WPS), Procedure Qualification Record (PQR) and Individual Welder Certifications shall be submitted in accordance with paragraph QUALIFICATIONS OF WELDERS.
 - 2. Welder's Certificate: Include welder's certification of compliance with ASME (BPV IX).
- E. Test Gauges: Submit manufacturer's material brochure on dial type pressure gauges to be used during the testing procedures for the hydronic piping.

- F. Qualifications of Independent Testing Firm or Firms: Submit the name, address, and telephone number of any firm or firms selected to conduct test.
- G. Isolation Valves: Gate valves shall conform to the product requirements specified in this Section. Submit manufacturer's material brochures.
- H. Pipe Sleeves: Submit manufacturer's material brochures indicating dimensions and certifying conformance to the contract drawing details.
- I. Manufacturer's Installation Instructions: Indicate support methods, joining procedures.
- J. Project Record Documents: Record actual locations and elevations of all piping, anchors, and valves.
- K. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- L. Manufacturer's Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.
- M. Piping Tests - Submit the following:
 - 1. Hydrostatic Testing Records: The Contractor shall maintain a constantly updated log (as described in this Section) available to the Owner and Design Professional at all times. The Construction Manager shall submit a final log to the Owner for record.
 - 2. Visual Examination - Examiner's Qualifications: Provide as specified in this Section.
 - 3. Visual Inspection Reports: Provide as specified in this Section.

1.7 PERFORMANCE REQUIREMENTS

- A. Provide a complete prefabricated conduit system for steel piping including jacketed carrier piping, fittings and installation accessories.
- B. The hydronic water system is designed for not less than 125 psig and an operating temperature between 40 and 250 degrees F. System components shall be suitable for maximum working pressure of ANSI Class 150. (150 psig SWP)
- C. The hydronic water system is a fully welded system that expands and contracts within the ground as operating temperatures vary.

1.8 QUALITY ASSURANCE.

- A. Country of Fabrication:
 - 1. All piping, fittings, and piping accessories not manufactured, fabricated, and/or assembled in the United States of America or Canada must be manufactured, fabricated, and/or assembled by an ISO 9001 registered corporation.
 - 2. Submit ISO 9001 registration certificates for all corporations where the piping, fittings, and piping accessories are not manufactured, fabricated, and/or assembled in the United States or Canada.
 - 3. For all piping, fittings, and piping accessories not fabricated in the United States or Canada, submit an independent test report for all materials to be provided.

4. No piping, fittings, and piping accessories manufactured, fabricated, and/or assembled in China including Taiwan are permitted to be provided in this project Contract.
- B. Manufacturer Certification: The prefabricated pipe manufacturer shall provide a certificate stating that the direct buried piping system was installed in accordance with the manufacturer's recommendations.

1.9 DELIVERY, STORAGE, AND PROTECTION

- A. Ship the underground hydronic premanufactured piping and conduit system with plastic pipe end covers secured with tape on the piping prior to shipment from the factory. Bag type covers are not acceptable.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage and store in a protected location.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 EXISTING PROJECT CONDITIONS

- A. Verify the size and flow direction of any connections to existing piping prior to performing any work.
- B. Sequence installation to ensure piping connections are achieved in an orderly and expeditious manner.

PART 2 PRODUCTS

2.1 UNDERGROUND HYDRONIC PIPING

- A. Manufacturer Layout Basis: Thermacor Jacketed Pipe
- B. Other Acceptable Manufacturers:
 1. Thermal Piping Systems
 2. Perma-Pipe
 3. Rovanco
- C. Corrosion protection coating shall include a layer of adhesive and covered with a high density polyethylene (HDPE) jacket conforming to ASTM D-1248, Type 3, Class C specifications. The HDPE jacket shall be seamless throughout, minimum thickness throughout, with minimum thickness of 150 mils.
- D. Factory fittings shall be prefabricated, preinsulated to minimize the number of field welds. Fittings shall be provided with one piece molded HDPE fitting covers. Factory fittings shall be welded by butt fusion or extrusion welding process.

- E. Field fabricated fittings and joints shall be jointed with shrink sleeve. Manufacturer closure kits shall be utilized in the field to secure joints.
- F. Sleeves shall be furnished by the manufacturer and installed watertight by the contractor.
- G. Terminate outer jackets 4" beyond the inside face of building walls or floors,
- H. Carrier Pipe:
 - 1. ASTM A 53/A 53M, grade B, ERW Schedule 40, black.
 - 2. Fittings: ASTM A 234/A 234M, wrought steel welding type.
 - 3. Joints: AWS D1.1, welded.

2.2 PIPE ANCHORS

- A. Prefabricated steel pipe anchors shall be provided where shown or required by the piping expansion analysis. Anchor plate shall be 1/2-in. thick minimum, welded to the carrier pipe and insulated. Anchor plate shall extend a minimum of 2-1/2-in. beyond the casing diameter on all sides and provided with a high temperature mastic corrosion coating.
- B. Each anchor assembly shall be poured within a concrete thrust block for firm anchorage into trench sidewalls and bed. Concrete block shall extend a minimum of 12-in. beyond all sides of the anchor plate, and at least 36-in. length. Refer to detail on Drawings.

2.3 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 - 1. Brady Identoline
 - 2. Seton 210
 - 3. Water Works Ind, Inc.
- B. Provide detectable aluminum foil plastic-backed tape or detectable magnetic color-coded polyethylene plastic tape for warning and identification of buried piping.
- C. Provide tape in minimum 4-inch width rolls, color coded for the utility involved, with warning and identification imprinted in bold black letters
- D. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.
- E. Warning tape shall read "CAUTION - BURIED PIPING BELOW" or similar wording at minimum 18-inch intervals over the entire tape length..

2.4 UNDERGROUND GATE VALVES AND ACCESSORIES

- A. Manufacturers:
 - 1. American Flow Control - 2500 Series
 - 2. M&H 7000
 - 3. Kennedy KS-RW

- B. Gate valves shall meet the requirements of AWWA C-515. Valve shall be rated for 250 psi working pressure and a minimum 300 psi test pressure.
- C. Valves shall be iron body, resilient seated, bronze-mounted, double disc, parallel seat or solid wedge, non-rising stem type fitted with "O-ring" seals, and fusion-bonded epoxy coating inside and out. Resilient materials shall be EPDM. The operating nut shall be 2" square. AR valves shall open left, or counterclockwise. Stuffing box shall be "O-Ring type."
- D. Flange joint shall be ANSI B16.1 standard.

2.5 VALVE BOX

- A. Manufacturers: U.S. Foundry, U.S. Pipe Co., Clow.
- B. Two piece, cast iron, round adjustable cast iron extension with identification of utility service on the top cover plate.

2.6 PIPE SLEEVES

- A. Fit all pipes passing through building walls and floors, with shop fabricated pipe sleeves or core drill with mechanical link seals. Extend each sleeve through its respective wall and cut flush on inside and outside surfaces. Provide sleeve size based on recommended link seal size for pipe or conduit being installed. Pipe sleeve shall be fabricated from Schedule 40, galvanized steel pipe conforming to ASTM A-53, Grade B.
- B. Attach leak plate around center of pipe sleeve unit prior to delivery. Install a mechanical type interlock seal, Buna-N links shaped to fill the annular area between the sleeve and pipe or conduit. Link type seal shall be installed on interior end of pipe sleeve.

PART 3 EXECUTION

3.1 PREPARATION

- A. The Contractor shall survey and lay out the new underground utility distribution route. Advanced trench excavation and physically locate underground utilities is advised to keep within the project schedule. Discovery of any unforeseen site conditions shall be reported to Architect as soon as they are encountered.
- B. Exact location of piping, direction of flow and fluid being handled shall be confirmed by Contractor prior to installing new piping to assure compatibility of system, fluid being pumped, and pipe sizes

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

- B. Provide all work, labor, materials and equipment to construct the underground utility distribution system into a complete, convenient and operating system.
- C. Group piping with other site piping work whenever practical.
- D. Establish elevations of buried piping to ensure not less than 4.0 ft of cover.
- E. Route pipe in straight line unless noted otherwise.
- F. Slope pipe as shown on profiles to match final elevations without dips or crowns in the piping.
- G. Maintain 4 inch clearance between pipe conduits, minimum.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Provide for pipe movement by installing bolster padding as indicated on the shop drawings.
- J. Install piping straight and true to bear evenly on trench floor
- K. Equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ANSI B31.3, except as modified herein.
- L. Protection against Hazardous Conditions: The Contractor shall notify Architect if a hazardous condition exists or conditions for a potential hazardous situation arises. If, in the opinion of Architect, a hazardous condition exists, work shall cease until such condition has been corrected.
- M. Cutting Existing Pipe: Perform the initial cutting of the existing pipe with a multi-wheel pipe cutter. After cutting, seal the interior of the piping with a barrier plug.
- N. Cleaning of Piping: Keep the interior and ends of new piping and existing piping affected by the Contractor's operations thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

3.3 EXCAVATION AND BACKFILL

- A. The Contractor shall excavate a minimum of 200 linear feet of trench prior to welding piping to fully assess field conditions.
- B. Trenching:
 - 1. Notify the Design Professional of unexpected subsurface conditions.
 - 2. Cut trenches wide enough to allow inspection of installed utilities.
 - 3. Hand trim excavations. Remove loose matter.
 - 4. Remove large stones and other hard matter which could damage piping or impede consistent backfilling or compaction.
 - 5. Remove excavated material that is unsuitable for re-use from site.

6. Remove excess excavated material from site.
7. Do not remove or damage any shrubbery, landscape, or trees except as specifically shown on plans. Notify Design Professional of any and all discrepancies.

C. Dewatering:

1. Contractor shall furnish all labor, materials, and equipment to keep the work free of water either from surface sources or from underground sources, or from both. The selection of the equipment and method of the removal of the water shall be the sole responsibility of the Contractor. The Contractor shall be responsible for all damage incurred in handling site water conditions.

D. Backfilling:

1. Backfill to contours and elevations indicated on the site drawings using unfrozen materials.
2. Employ a placement method that does not disturb or damage other work.
3. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
4. Place and compact bedding courses on trench bottoms and where indicated. All trenches shall be excavated a minimum of 6-inches below pipe bottoms and refilled with sand, tamped to stabilize base, and then covered with 6-inch minimum cover of clean sand. The sand shall be compacted to 95% standard Proctor dry density prior to installation of piping. Trench bottoms shall form a straight line free of dips or humps with no offsets in any plane other than shown on the drawings. The initial 2-feet of backfill over piping shall be placed in 4-inch layers and hand tamped. The remainder of backfill may be machine tamped.
5. Compaction density unless otherwise specified or indicated shall be not less than 90% of maximum dry density.

3.4 PIPE AND FITTINGS

A. General

1. Inspect, test, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for connections. Reducing branch connections in steel piping may be made with forged branch outlet reducing fittings for branches two or more pipe sizes smaller than mains. All changes in direction shall be made with factory-fabricated welded pipe fittings, and all elbows shall be long radius. Tees are used on the outlets, but the use of fittings formed from pipe sections shall not be permitted.
2. All pipe shall be accurately cut to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation shall not be permitted. Pipe ends shall have burrs removed by reaming and pipe shall be installed to permit free expansion and contraction without damage to joints.

- B. Fittings and End Connections: Install threaded fittings and end connections for sizes less than one inch; threaded or socket-welding or butt welding fittings and end connections for sizes 1 to 2 inches; threaded connections for threaded valves, traps, strainers, and threaded connections to equipment; butt welded fittings and end connections for sizes 2.5 inches and larger; and flanged connections for flanged valves, and flanged connections to equipment as otherwise specified.

3.5 UNDERGROUND VALVES

- A. Set valves on solid bearing with concrete base as detailed.
- B. Provide valve with square operating nut and provide extension to underneath bottom of C.I. valve box cover.
- C. Center and plumb valve box over valve. Set box cover flush with concrete pad on finished grade.
- D. Placement of valve stations shall be approved by the Architect Design Professional for final coordination with the site landscape design.

3.6 WELDING

- A. Welding Responsibility
 - 1. Responsibility of Contractor for Fusion Welding:
 - a. The Contractor is entirely responsible for the quality of the welding required for the underground piping distribution system.
- B. Qualifications of Welders:
 - 1. Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform to ANSI B31.1 for the qualification of procedures, welders and welding operators. The Contractor shall be required to follow the qualification of procedures by destructive testing as outlined in paragraph QW302 of Section IX of the ASME Boiler and Pressure Vessel Code. The welders shall be certified under rules of the National Certified Pipe Welding Bureau and qualified by either the National Certified Pipe Welding Bureau or an independent testing laboratory. Copies of the welder's certificates shall be made available to the Owner and Design Professional upon request.
 - 2. Documentation of the welding procedure and the welder qualification shall be presented in the form of a Welding Procedure Specification (WPS), and Procedure for Qualification. The welder or welding operator must submit a welder certification verifying his qualification to the procedure. The Welding Procedure Specification (WPS) shall meet the requirements of this specification.
- C. Beveling:
 - 1. Field bevels and shop bevels shall be done by mechanical means. All beveling shall conform to the Welding Procedure Specification (WPS).
- D. Welding Rings:
 - 1. Welding rings shall not be used on this project.
- E. Erection:
 - 1. Piping shall not be split, bent, flattened, or otherwise altered either before, during, or after installation.
 - 2. During erection care shall be taken to remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before tying in sections, valves, or fittings.

3. Where the pipe temperature falls to 32 degrees F or lower, the pipe shall be heated to approximately 100 degrees F for a distance of 1 foot on each side of the weld before welding, and the weld shall be finished before the pipe cools to 32 degrees F.

F. Defective Welds:

1. Defective welds shall be replaced and re-inspected at no additional cost to the Owner. Repairing defective welds by adding weld material over the defect or by peening will not be permitted.
2. Welding repairs will be performed in accordance with an approved welding repair procedure. The repair procedure shall be submitted to the Engineer for approval before performing repairs.
3. When the quality of a welder's work appears to be below the requirements of the acceptance criteria, the inspector shall require the welder to demonstrate his ability to produce sound welds by means of complete requalification.

G. Electrodes:

1. All low hydrogen electrodes shall be stored in a storage oven that is kept free of moisture and dampness during fabrication operations.
2. Low hydrogen electrodes shall not remain out of the storage oven for more than four (4) hours at a single time.
3. If the electrodes are placed back into the storage oven, they shall remain for a minimum of 24 hours before being used.
4. Electrodes that demonstrate contamination, loss of coating or any other form of damage shall be discarded.

3.7 PROTECTIVE COATING

A. Damaged Materials:

1. Fittings, couplings, irregular surfaces, damaged areas of pipe coating, and existing piping affected by the Contractor's operations shall be clean, dry, grease free, and primed before application of tape.
2. Pipe coating and adhesive undercoat surfaces to be wrapped with tape shall be primed with a compatible primer prior to application of tape. Primer shall be as recommended by tape manufacturer and approved by pipe coating manufacturer.
3. Waterproof shrink sleeves may be provided in lieu of tape and shall overlap the pipe coating not less than 6 inches.

B. Pipe Coating:

1. Residual material from pipe coating shall be pressed into the break or trimmed off.
2. Apply tape spirally with one-third overlap as tape is applied.
3. A double wrap of one full width of tape shall be applied at right angles to the axis to seal each end of the spiral wrapping.
4. All damage to the piping shall be repaired in accordance with the manufacturer's recommendations.

C. The Finishing Coating:

1. Stretch and apply first layer of tape to conform to component's surface.
2. Apply and press a second layer of tape over first layer of tape.

- D. Flange, Valve, and Irregular Surface Coating:
 - 1. Apply coal tar base coating to a minimum dry film thickness of 30 mils.

3.8 FLUSHING STANDARDS AND SPECIFICATIONS FOR WATER DISTRIBUTION SYSTEM CARRIER PIPING

- A. Fill and flush with clean water.
- B. Refill with clean water, then add cleaning chemicals as recommended by the chemical water treatment vendor, supplied and supervised by the water treatment vendor. Refer to Section 23 2500.
- C. Install chemicals and circulate water, using temporary pumps as required, in each system for 48 hours. Minimum water velocity is 6 feet per second.
- D. At the end of each 48 hours, remove and clean strainers. Blow-off low points.
- E. Do on-line flushing using a fast "feed and bleed" procedure for 24 hours. Be sure all parts of the system are on-line during the cleaning. Circulate all dead legs of the system. Provide temporary piping crossovers as required.
- F. Do final system drain and blow off low points.
- G. When cleaning is completed, fill systems with clear and clean water, and notify Owner and Design Professional of completion of these steps.
- H. Use and disposal of chemicals shall comply with local, state, and federal regulations.
- I. The contractor is responsible for monitoring the draining procedures to prevent flooding on the site.
- J. Introduce closed system treatment from the campus Central Energy Plant chilled water piping loop connection, supplied and supervised by the water treatment vendor. Refer to Section 23 2500.

3.9 BURIED UTILITY WARNING TAPE

- A. Bury tape with the painted side up at a depth of 6-inches above top of sand backfill. Locate a second tape buried at 6-inches below grade where top of pipes are buried at 6-ft. or greater depth.

3.10 PIPING TESTS - VISUAL EXAMINATION (VT)

- A. General: Visually examine all pipe welds per ASME B31.1. As described below, visual examination of welds may be performed by the Construction Manager or an independent testing agency.
- B. Welding Tests: Twenty-five percent (25%) of all field welds shall be inspected using this method.

C. Acceptance Standards:

1. The acceptance standards for visual examination shall be as defined in ASME B31.1. The following indications are unacceptable:
 - a. Cracks-external surface.
 - b. Undercut on surface which is greater than 1/32 inch deep.
 - c. Weld reinforcement greater than that specified in Table 127.4.2. of ASME B31.1.
 - d. Lack of fusion on surface.
 - e. Incomplete penetration (applies only when inside surface is readily accessible).
 - f. Any other linear indications greater than 3/16 inch long.
 - g. Surface porosity with rounded indications having dimensions greater than 3/16 inch or four or more rounded indications separated by 1/16 inch or less edge to edge in any direction. Rounded indications are indications which are circular or elliptical with their length less than three times their width.
2. In addition, acceptance will also be based on the proper lay-out, materials, and methods, as specified.

D. Failed Welds:

1. All welds not passing visual examination shall be repaired or replaced at no expense to the Owner.
2. Repair shall be performed using the qualified welding procedures applicable to the original weld.

E. Reporting:

1. Reports for visual examinations of welds shall be required for all piping larger than 3 inch NPS except for vent and drain services. Reports performed for visual examinations are not required to be submitted, but shall be kept available for review at any time by the Owner or Engineer.
2. Each weld report shall include the following:
 - a. Date of weld examination.
 - b. Type of examination.
 - c. Examiner's name.
 - d. Welders' names including all persons who worked on the weld and their work involved.
 - e. Piping system.
 - f. Weld location.
 - g. Weld procedure and materials.
 - h. Materials and dimensions of items that were welded.
 - i. Visual examination results.

F. Examiners' Qualifications:

1. Contractor personnel may perform visual examinations as long as the persons have passed the Contractor's welding quality control program that satisfies the requirements of ASME B31.1.

G. Visual Examination Requirements:

1. Welds designated for visual examination shall be examined as follows:
 - a. Before welding - for compliance with requirements for joint preparation, alignment and fit-up, cleanliness, condition of welding equipment, quality and condition of base and filler materials to be used, and preheat, when required.

- b. During welding - for cracks, conformance to the qualified welding procedure, quality of individual weld passes, interpass temperature, placement and sequencing of individual weld passes, and backgouged surfaces.
 - c. After welding - for cracks, contour and finish, bead reinforcement, undercutting, overlap, size of fillet welds, finished weld appearance, weld size, weld length, dimensional accuracy of weldment, and monitor post weld heat treatment.
2. The inspector shall initial and date each field weld using a paint pen for marking on the outer casing.
 3. Records of visual examinations must be kept as described in this Section.

H. Examiner's Scope:

1. Visual examinations to be performed by the Construction Manager may be performed and interpreted by an employee of the Construction Manager, provided that each individual is certified as specified. As an option, the Construction Manager may obtain the services of an independent testing agency to perform these examinations.
2. A welder who has performed any work with regard to a specific weld shall not perform the visual examination of the same weld unless approved by the Construction Manager's welding quality control program.

3.11 PIPING TESTS - PRESSURE TESTING OF UTILITY PIPING

A. General:

1. Tests shall be conducted before, during, and after the installation of the system.
2. All instruments, equipment, facilities, and labor required to properly conduct the tests shall be provided by the contractor.
3. Test pressure gages shall have dials indicating not less than 1-1/2 times or more than 2 times the test pressure.
4. Provide 48 hours notification to the Design Professional and the project site representative in advance of each pressure test.
5. Any deficiencies shall be corrected at Contractor's expense. Failures to correct any deficiencies will be cause for rejection of the system.

B. Field Tests: The following field tests shall be conducted on the piping system. If any failure occurs, Contractor shall make such adjustments or replacements as Architect may direct, and the tests shall be repeated until satisfactory installation and operation are achieved.

1. Hydrostatic Tests:

- a. Test piping system hydrostatically using water not exceeding 100 degrees F.
- b. Conduct tests in accordance with the requirements of ANSI B31.1. Test pressure shall be 150 psig.
- c. Test the piping system after the lines have been cleaned and before any insulation covering has been applied in areas of field welds and the underground conduit system.
- d. Before making tests, remove or valve off from the system any apparatus that may be damaged by the test pressure.
- e. Install calibrated test pressure gages in the system to observe any loss in pressure.
- f. Maintain the required test pressure for a minimum of four (4) hours.

- g. Inspect all joints and connections for leaks. Perform tests after installation and prior to acceptance.
- h. Air testing of carrier piping is not permitted.
- 2. Joint Closure Tests:
 - a. Test jacket closure at joints with air pressure at 5 psi for a minimum of 15 minutes. Follow installation and testing procedures as recommended by the manufacturer.

3.12 VERIFICATION OF FINAL ELEVATIONS

- A. Prior to covering the top of piping with backfill, but after all temporary supports have been removed, pipe bedding installed and initial backfilling completed, the Construction Manager shall measure and record the elevation of the top of the casing installed at each elbow or change in direction. These measurements shall include each building entrance location. These measurements shall be checked against the contract drawings and recorded by the Construction Manager for documentation to the Owner.
- B. The Construction Manager shall measure and record physical dimensions of the piping to a known and durable surface or corner so the piping can be located in the future. These dimensions shall be provided in several locations to adequately identify the pipe routing.
- C. The Construction Manager shall measure and record the top elevation of any piping or ductbank that intersects the underground piping route.
- D. All elevations shall be recorded using a surveyor's level and survey rod.
- E. The Construction Manager shall produce a drawing of the underground utility piping that shows the recorded installation conditions.

3.13 MANUFACTURER'S FIELD SERVICES

- A. A MANUFACTURER'S REPRESENTATIVE of the piping system used shall inspect the installation of the distribution system and shall provide Architect for Owner a certificate on the manufacturer's letterhead stating that the pipe is installed in accordance with the manufacturer's recommendations and provide the manufacturer's warranty.
- B. The representative shall be a factory-trained technician with a minimum of two years' experience.
- C. The representative shall meet with the installer and confirm that the manufacturer's installation instruction have been read and understood.
- D. The technician must observe the following critical periods of construction:
 - 1. Unloading of the piping system.
 - 2. Welding of at least one hydronic pipe connection and fitting.
 - 3. Assembly and testing of one jacket field joint.
 - 4. Preparation of pipe bed and the initial backfilling operation.
- E. A field report shall be submitted for each site visit documenting the progress of the installation with photographs, and noting any deficiencies. Submit two copies of each

report to the Construction Manager, one copy to the Owner, and two copies to the Design Professional.

END OF SECTION 23 2140

SECTION 23 2300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Moisture and liquid indicators.
- C. Filter-driers.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 23 0719 - HVAC PIPING INSULATION.

1.3 REFERENCE STANDARDS

- A. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.
- B. AHRI 750 - Standard for Thermostatic Refrigerant Expansion Valves; 2007.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.
- D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- F. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2013.
- G. ASME B31.9 - Building Services Piping; 2014.
- H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- J. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2013.
- K. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

- M. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- N. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; 2003.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Liquid Indicators:
 - 1. Provide line size liquid indicator in main liquid line leaving condenser.
- C. Filter-Driers:
 - 1. Provide a filter-drier immediately ahead of liquid-line moisture and liquid indicators.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, slopes, piping components and pipe sizes.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- F. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of documented experience.

1.7 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers with dry nitrogen, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 PIPING

- A. Copper Tube: ASTM B 280, H58 hard drawn . Soft tempered "coils" shall not be acceptable.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints:
 - a. Coil connections, and within equipment cabinets: Soldered ASTM B32 lead and antimony free solder, 96 Sn/4 Ag (tin-silver) alloy with zinc fluoride flux. Typical product is Harris Product Group 'Stay -Brite' with 'Staya-Clean' flux.
 - b. Couplings, Tees and elbows in piping mains and branches:
 - 1) Brazed. AWS A5.8/A5.8M BuCP copper/silver/phosphorous alloy, minimum 1485 degree F liquidus.
 - 2) Solder shall be rated for recommended joint clearance of 0.002" to 0.006".
 - 3) Silver content shall be 5-15%, except 6% silver alloys are not acceptable.
 - 4) Typical products are Harris Product Group 'Stay-Silv 15', 'Stay Silv 5' and 'Dynaflow'.
- B. Pipe Supports and Anchors:
 - 1. Upper attachments shall not attached to roof or floor decks. Upper attachments shall be attached to structural members
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 5. Wall Support for Single Pipe Sizes to 3 Inches: Carbon steel extension split ring pipe clamp, Figure 455.
 - 6. Vertical Support: Steel riser clamp.
 - 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.2 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Henry Technologies: www.henrytech.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.

- B. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 650 psi.

2.3 FILTER-DRIERS

- A. Manufacturers:
 - 1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.
 - 2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com/#sle.
 - 3. Sporlan Valve Company: www.sporlan.com/#sle.
- B. Performance:
 - 1. Flow Capacity - Liquid Line: Nominal unit tonnage, minimum, rated in accordance with ARI 710.
 - 2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 - 3. Design Working Pressure: 650 psi, minimum
 - 4. UL Listed.
- C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns; of construction that will not pass into refrigerant lines.
- D. Construction: UL listed.
 - 1. Connections: As specified for applicable pipe type.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.
 - 8. Upper attachments: .
 - a. Provide attachment to upper cord of bar joist or to flanges of steel beams. Attach with beam clamps or other listed devices for this purpose.
 - b. Do not support from roof deck.
 - c. Weights of 15# or less may be supported from floor decks.
 - d. Unless otherwise noted, connect pipe supports to structural members only. Where structural members do not occur above piping, provide supports spanning between members. Supports shall be sized for weight to be supported.
- G. Arrange piping to return oil to compressor. Provide traps and loops in piping as recommended by manufacturer or as detailed. Slope horizontal piping 0.40 percent in direction of flow.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Flood piping system with nitrogen when brazing.
- J. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- K. Insulate piping; refer to Section and Section 23 0716.
- L. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- M. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using electronic leak detector. Test to no leakage.
- C. Pressure test for 6 hours minimum duration.

- D. Vacuum test; 500 microns; 15 minutes minimum duration.
- E. Break vacuum with dry nitrogen and re-evacuate to 500 microns a second time.
- F. Break vacuum with dry nitrogen and re-evacuate to 500 microns a third time.
- G. Break vacuum with refrigerant charge.

3.4 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION 23 2300

SECTION 23 2500 - HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flushing and Cleaning of piping systems.
- B. Chemical feeder equipment.
- C. Tower basin cleaning system.
- D. Chemical treatment.
- E. Maintenance Services.

1.2 RELATED REQUIREMENTS

- A. Section 15065 - Motors for Mechanical Equipment.
- B. Section 23 2113 - HYDRONIC PIPING.
- C. Section 23 2114 - HYDRONIC SPECIALTIES.
- D. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- E. Cleaning and Flushing: Contractor shall submit a written Cleaning and Flushing Plan to the Architect and the Commissioning Agent for review prior to performing this work.
- F. Manufacturer's Field Reports:
 - 1. Provide service report certifying that systems have been cleaned in accordance with the specified procedures.
 - 2. Provide service report certifying start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

- G. Operation and Maintenance Data: Include data on chemical feed pumps and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
- H. Certificate: Provide Manufacturer's Certificate in accordance with the requirements of the General Conditions.

1.4 QUALITY ASSURANCE

- A. The water treatment products and services for this project shall be provided by:
 - 1. Superior Water Services, Inc. (SWS)
- B. Service company shall have local representatives with water analysis laboratories and full time service personnel.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. The contractor shall be responsible for coordination of all subcontractors involved in the installation of mechanical systems requiring flushing, cleaning, and water chemical treatment.
- C. The contractor shall not operate any system in whole or part for more than 48 hours without proper water treatment. Immediately after flushing, chemical passivation and cleaning shall be performed, followed by the chemical treatment.
- D. If any systems are allowed to operate untreated or with inadequate protection for a period of more than 48 hours, the contractor shall provide an extended warranty for the system and associated equipment.
- E. The contractor shall be responsible for any cost incurred for reflushing/recleaning and treatment of any system allowed to run untreated or with inadequate water treatment.
- F. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.6 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from Date of Material Completion.
- B. Furnish a one year supply of water treatment chemicals required for service of the closed loop and open loop hydronic systems specified in this section.
- C. Provide Monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating

requirements, and corrective actions needed. Submit two copies of field service report after each visit to the Owner Facilities Manager.

- D. Provide laboratory and technical assistance services during this maintenance period.
- E. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at startup of systems.
- F. At the end of the 12 month service period, submit a written report on the test analysis of the corrosion and scaling coupons.

1.7 MAINTENANCE MATERIALS

- A. Supply sufficient chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.1 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
 - 2. The cleaner shall contain an inorganic phosphate, an organic corrosion inhibitor, dispersant, and an oil emulsifier.
- B. Closed System Treatment (Condenser Water):
 - 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 2. Corrosion inhibitors shall be a multi-functional blend of nitrite, molybdate, tolytriazole, anionic polymer, and buffering agent, or Owner approved equal.
- C. Tower Water System Treatment (Cooling Towers):
 - 1. Sequestering agent to inhibit scaling; phosphonates, sodium polyphosphates, lignin derivatives, synthetic polymer polyelectrolytes, or organic phosphates.
 - 2. Corrosion inhibitor; zinc-phosphate, phosphonate-phosphate, phosphonate-molybdate and phosphonate-silicate, sodium tolytriazole, or low molecular weight polymers.
 - 3. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

2.2 GLYCOL

- A. Type: Inhibited propylene glycol.
- B. Dye: Provide red dye solution which meets manufacturers recommendation for compatibility and performance.

2.3 BY-PASS (POT) CHEMICAL FEEDER

- A. Manufacturers:
 - 1. Dearborn; Model AV.
 - 2. Mogul; Model 7.
 - 3. Neptune Chemical Pump Company; Model FTF: www.neptune1.com/#sle.
- B. 5 gal minimum tank size for working pressure of 175 psi with quick opening cap and pipe tapings.

2.4 SOLUTION METERING PUMPS

- A. Manufacturers:
 - 1. Industrial Chemical Corporation.
 - 2. LiquidMetronics(LMI).
 - 3. Neptune Chemical Pump Company: www.neptune1.com/#sle.
- B. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.
- C. Provide 1/4-1/8 inch tubing connections, foot valves, and injection fittings sized as required for the chemical services.
- D. Electrical Characteristics:
 - 1. 120 volts, single phase, 60 Hz.
 - 2. Cord and Plug: Provide unit with 6 foot cord and plug for connection to electric wiring system including grounding connector.

2.5 SOLUTION TANKS

- A. 30 gallon capacity, minimum, double wall containment, polyethylene, self-supporting, one gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.
- B. Containment: Provide a rectangular polyethylene containment basin to provide a minimum 110% containment volume of the chemical solution tanks mounted in the basin.

2.6 LIQUID LEVEL SWITCH

- A. Manufacturers:
- B. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low level alarm.

2.7 CONDUCTIVITY CONTROLLER

- A. Manufacturers:

1. Envirocare: www.envirocare.com/#sle.
 2. JENCO Instruments Incorporated: www.jencoi.com/#sle.
 3. LMI Milton Roy.
 4. Omega Engineering, Inc: www.omega.com/#sle.
- B. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit, dual biocide timers, and flow switch.
1. Conductivity Monitor: Capable of linear, temperature compensated, measurements directly in micromhos (umhos) over full scale. Four ranges of measurement shall be provided, 0-500 umhos, 0-2000 umhos, 0-20,000 umhos; which shall be field selectable. Conductivity shall be displayed digitally from an alpha numeric lighted display. Controller adjustments for setpoint, manual-off-automatic operation, and calibration shall be front panel mounted for east access.
 2. Feed Control: Capable of controlling chemical feed to allow for variable operating conditions.
 - a. Percentage of bleed time.
 - b. Feed based on metered make-up with a pulse timer and accumulator.
 - c. Integral feed limit timer to prevent overfeed. Timer shall be accessible from the front panel for adjustment.
 3. Conductivity Probe: Probe and flow switch shall be pre-mounted and wired to the controller. The flow switch shall interlock the control functions on a low flow condition.
 4. Biocide Feed: Oxidizing biocide feed shall be controlled by the conductivity controller. For application of the non-oxidizing biocide, the controller shall have a biocide selector.

2.8 WATER METER

- A. Manufacturers: Refer to Section 22 0519 for the domestic cold water makeup meters.

2.9 SOLENOID VALVES

- A. Forged brass body globe pattern, normally open or closed as required, general purpose solenoid enclosure, and continuous duty coil.

2.10 TIMERS

- A. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hand-off-automatic switches and status lights.

2.11 TOWER BASIN CLEANING SYSTEM

- A. Manufacturers:
 1. Lakos.
 2. PEP Filters.

- B. System: Close coupled pump and centrifugal separator pre-piped and pre-wired on skid and field installed sweeper piping in tower(s) with eductor nozzles.
- C. Performance: Design flow 200 gal/min with maximum pump horsepower of 5 HP.
- D. Close Coupled Pump:
 - 1. Type: Horizontal shaft, single stage, close coupled, radially split casing, for 125 psi maximum working pressure.
 - 2. Casing: Cast Iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
 - 3. Impeller: Bronze, fully enclosed, keyed to motor shaft extension.
 - 4. Shaft: Stainless Steel.
 - 5. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- E. Centrifugal-action type separator shall be epoxy or acrylic enamel coated carbon steel rated for 150 PSIG with automatic purge valve, and NEMA 4X Control panel with disconnect, overloads, and purge timer with manual override.
 - 1. To ensure maximum particle removal characteristics, the separator shall incorporate a vortex-induced pressure relief line, drawing specific pressure and fluid from the separator's extended solids collection chamber via the outlet flow's vortex/venturi effect, thereby efficiently encouraging solids into the collection chamber. System fluid shall exit the separator by following the center vortex in the separation barrel and spiral upward to the separator outlet.
- F. Automatic Purge Valve: An electrically-actuated valve shall be programmed at appropriate intervals and duration in order to efficiently and regularly purge solids from the separator's collection chamber. Valve body shall be bronze. Valve ball shall be stainless steel with sealant seat.
- G. Sweeper Piping:
 - 1. PVC: ASTM D 1785, Schedule 80, or ASTM D 2241, SDR 21 or 26.
 - 2. Fittings: ASTM D 2466, or ASTM D 2467, PVC.
 - 3. Joints: Solvent welded.
- H. Electrical Control: Fusible disconnect starter with overload module; HOA selector switch; NEMA-4X enclosure; re-set/disconnect/trip switch; 120 volt, single phase control voltage; UL Listed. Power requirement: 460 volt, 3 phase, 60 Hz;
- I. Skid Plate: Stainless steel, 3/16-inch (5 mm) minimum thickness

PART 3 EXECUTION

3.1 PREPARATION

- A. Systems shall be flushed, filled, started, and vented prior to cleaning.
- B. The contractor shall velocity flush the piping systems prior to the introduction of chemical cleaning and treatment. Temporary pumps required to provide this flow shall be provided by the contractor. Temporary piping connections shall be provided as required to form a closed loop piping system to achieve the recirculation. Provide temporary venting as

required to enable a full system fill. The velocity flush is required only for steel piping systems.

- C. A flush shall consist of moving three times the volume of the system through the piping at the required flow rate. Two flushes will be required as minimum. Additional flushes may be required as needed. The system being flushed must be displaced with clean water after each flush.
- D. Submit the velocity flush plan for review and approval prior to the flush procedure. Include information on the pump to be used to accomplish the flushing.
- E. Contractor shall flush all systems with clean water including mud from drip legs. Remove, clean, and replace all strainers.
- F. Complete circulation shall be achieved during the cleaning procedure with a minimum flow rate velocity of 2 ft/sec. All manual and automatic control valves must be in the open position.
- G. All dead end pipe runs must be looped together with piping not less than 1/3 the size of run, and remain in place until cleaning is complete.
- H. Provide drain ball valves in the low points of each system for the purpose of draining the system.

3.2 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer to remove oil and grease and provide a uniform passivation film.
- B. Condenser Water System:
 - 1. Circulate for 36 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
 - 4. Open and drain mud legs and low points periodically during the cleaning process.
- C. Tower Water System:
 - 1. Circulate for 36 hours, then drain systems as quickly as possible.
 - 2. Allow the cooling tower sump basin and piping system to drain and refill with clean water, while circulating for 24 hours.
 - 3. Test system water and verify system fill is equal to clean make-up water. If required, refill with clean water and repeat until system cleaner is removed.
 - 4. Open and drain mud legs, remove sludge, and flush low points periodically during the cleaning process.
- D. Use neutralizer agents on recommendation of system cleaner supplier.
- E. Remove, clean, and replace strainer screens.
- F. Remove strainer start-up screens and leave at strainer until the completion of Project observations.

- G. Inspect make-up water stations, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

- A. Provide one bypass chemical feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass chemical feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.5 TOWER BASIN CLEANING SYSTEM:

- A. Locate eductor nozzles in the tower basin as directed by the manufacturer of the system to sweep debris from the cooling tower basin.
- B. Install interconnecting supply and return piping between piping in the cooling tower basin and pump/separator skid.
- C. Route separator drain to a floor drain in the mechanical equipment room.
- D. Filtration System to work in conjunction with Manufacturer's factory installed cold water basin sweeper piping.

3.6 TOWER WATER SYSTEMS (COOLING TOWERS)

- A. Refer to Detail on Drawings.
- B. Provide automatic condenser water control systems for inhibitor feed, blowdown and biocide feeds. Inhibitor application shall be meter activated, blowdown shall be conductivity activated, and biocide shall be meter fed with blowdown locked out to ensure biocide retention time.
- C. Control system shall incorporate solid state integrated circuits and digital LED displays, in NEMA-12 steel enclosure. Provide gasketed and lockable door.
- D. Provide water meter on cooling tower system domestic make-up water to activate solution pumps for preset time when condenser water pumps are running, interfaced with the plant BAS. Refer to Section 22 0519.

- E. Provide solution pumps to feed sequestering agent, biocides, and corrosion inhibitor from solution tanks into condenser water supply to tower. Provide agitator as required.
- F. Provide conductivity controller to sample condenser water and operate 1 inch solenoid bleed valve and piping to blowdown controller sampler wired to open when condenser water pump is operating.
- G. Introduce biocide to tower by intermittent slug feed or continuous feed solution pump.
- H. Provide 3/4 inch water coupon rack in the open loop condenser water piping with space for 4 test specimens.
- I. Project documents provide chemical treatment equipment. Do not operate equipment until chemical treatment systems are fully installed and functional.
- J. Maintain chemicals in system when operating equipment for start-up, testing, and completion of construction until acceptance of building by Owner.

3.7 MANUFACTURERS FIELD SERVICES

- A. Provide services of factory trained representative to inspect the piping installation and test the cleanliness of the project piping systems before chemical treatment, Representative shall drain low points and check system strainers for cleanliness and ensure piping systems are clean and ready for chemical treatment.
- B. Factory trained representative shall start-up and calibrate chemical feed controls provided under this Section.
- C. Factory trained representative shall test each system chemical treatment prior to the Request for Material Completion.
- D. Demonstrate system operation to Owner and instruct Owner in required maintenance.
- E. Provide start-up certificate certifying that the piping systems have been cleaned and treated as specified.

END OF SECTION 23 2500

SECTION 23 3100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Flexible Ducts.
- C. Ductwork Fabrication.
- D. Manufactured casing and plenums.
- E. Fabric ducts.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 23 0510 - Mechanical General - Ductwork Shop Drawings
- C. Section 23 0713 - DUCT INSULATION: External insulation and duct liner.
- D. Section 23 3300 - AIR DUCT ACCESSORIES.
- E. Section 23 3600 - Air Terminal Units.
- F. Section 23 3700 - AIR OUTLETS AND INLETS.
- G. Section 23 0593 - TESTING, ADJUSTING AND BALANCING FOR HVAC.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- B. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2016.
- C. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2015.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- E. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2015.

- F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- G. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric); 2011.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- I. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 1985, First Edition.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- K. SMACNA Round Industrial Duct Construction Standards; 1999, 2nd Edition.
- L. SMACNA - Duct Cleanliness for New Construction Guidelines., 2000.
- M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.4 DEFINITIONS

- A. Low Pressure Duct: Duct having Pressure Class of 2-inches or less.
- B. Medium or High pressure Duct: Duct having Pressure Class over 2-inches.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data for :
 - 1. Flexible ducts and fabric ducts.
 - 2. Duct take-off fittings.
 - 3. Manufactured metal ductwork and fittings.
 - 4. Transverse Duct Connection System.
- C. Ductwork Shop Drawings:
 - 1. Provide dimensioned drawings indicating apparatus casing layout plan and sections of all casings indicating equipment, doors, service access and supplemental structural support requirements, if any.
 - 2. Refer to Section 23 0510 for duct shop drawing requirements.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- E. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

- F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.8 DELIVERY, STORAGE, AND PROTECTION (REFER TO DUCT CLEANLINESS LEVEL SPECIFIED IN INSTALLATION)

- A. Store in clean dry place and protect from weather and construction traffic.
- B. Exercise care during construction to prevent the accumulation of dust, dirt, and refuse in the supply and return ductwork.
- C. All openings shall be tightly closed with 8-mil polyethylene when work creating dust and debris is in progress.
- D. Exposed Spiral Duct in finished spaces:
 - 1. Accept products on site in protective wrapping. Inspect for damage.
 - 2. Protect surface and finish from damaged(dings), grease or other contaminants affecting duct finish.
 - 3. "Nested" shipment for exposed duct shall not be acceptable.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
- B. Provide Paint-Grip finish on exposed galvanized ducts for field painting.
- C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid, non-fibrated, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 2. VOC Content: Not more than 50g/L, excluding water.
 3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
 4. Products:
 - a. Manufacturers (water based): Ductmate Proseal, Hardcast IronGrip 601, Marathon 460, Foster 32-19; Childers CP-146; DuroDyne SAS.
- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 DUCTWORK FABRICATION

- A. General: Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- C. All dimensions are net inside metal measurements in inches unless otherwise shown.
- D. Duct sizes shown include allowance for liner thickness unless otherwise noted, except sizes shown for lined double-wall round spiral and double-wall rectangular duct are sizes of perforated inner liner.
- E. Exposed Duct:
 1. Exposed duct in finished spaces shall be Spiral duct and fittings.
 2. Exposed duct finish shall be mill phosphatized for field painting.
 3. Provide segmented standing seam on exposed duct in finished spaces.
 4. Provide welded joints and seams where indicated in the Schedule. Grind and polish all welded seams. Weld stainless steel with S.S. rod and brush with stainless wire brushes.
 5. Fabricate continuously welded round and flat oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
- G. Low Pressure Duct- Supply, Return, and Exhaust (2" Class or less):
 1. Longitudinal Seams:
 - a. Corner Seams: Fig. 2-2, Type L1 (Pittsburgh Lock).
 - 1) Corner seams for ducts less than 18 inch, L-2 (Button Punch Snap Lock) is acceptable.
 - b. Fig. 2-2, Type L-3 for seams other than corner.

2. Transitions:
 - a. Changes in duct sizes shall be made by transitions.
 - b. Refer to Fig. 4-7, CONCENTRIC TRANSITION, unless otherwise noted.
 - c. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - d. Transitions shall be provided between equipment and duct where sizes are not the same.
3. Rectangular Duct:
 - a. Elbows:
 - 1) Mitered with turning vanes. Type RE 2, Figure 4-2, unless otherwise noted.
 - b. Turning Vanes:
 - 1) Turning vanes shall be in accordance with Figs 4-3 and 4-4, unless otherwise noted.
 - 2) Provide single wall vanes for ducts 18" width or less.
 - 3) Provide double wall vanes for ducts over 18" width.
 - c. Splits and Tees:
 - 1) Fig. 4-5, Type 1, Type 2 (with stationary splitter), 4A, or 4B only.
 - 2) Use of Square Throat Elbow with Turning Vanes is acceptable, unless otherwise noted.
 - (a) Provide volume control damper in each branch.
 - 3) Omit volume control damper in Return and Exhaust duct unless otherwise noted.
 - d. Where acoustical lining is indicated, provide acoustical turning vanes of perforated metal with glass fiber insulation.
4. Round Duct Manufactured Spiral Duct:
 - a. Elbows: Radius elbow with radius not less than 1-1/2 times width of duct on centerline.
5. Branch and Runout Connections:
 - a. Entry fittings for Return and Exhaust: Construct for a 45 degree entry angle to ease the turbulence created by converging airstreams. Increase the minimum length shown in Fig. 4-6, 45 DEGREE ENTRY, from 4 inch to 6 inch.
 - b. Rectangular Branch or Runout from Rectangular Duct:
 - 1) Fig. 4-6, 45 DEGREE ENTRY, with flange and gasket for connection to trunk with a minimum of six screws.
 - c. Round Branch or Runout from Rectangular Duct:
 - 1) Fig. 4-6, 45 DEGREE LEAD IN, with flange and gasket for connection to trunk with a minimum of six screws.
 - 2) Provide volume control damper with locking quadrant at branch or runout connection unless over inaccessible ceiling (Refer to Grille Schedule on Drawings for neck mounted volume dampers).
 - d. Round Branch or Runout from Round Duct:
 - 1) Fig. 3-5, 45 DEGREE ENTRY TEE fitting with oval to round tap.
 - 2) Fig. 3-6, CONICAL TEE fitting.
 - e. Rectangular Runout to Sidewall Grille/Register:
 - 1) Fig. 4-6, 45 DEGREE ENTRY, with flange and gasket for connection to trunk with a minimum of six screws.
6. Offsets: Fig. 4-7, Type 1 and Type 3 only, unless otherwise indicated.
7. Dampers: Fig. 7-4, SINGLE BLADE TYPE, or 7-5, MULTIBLADE TYPE.

8. Reinforcement:
 - a. Tie Rod Reinforcement is NOT acceptable.
- H. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- I. Field Fabricated Mixing Plenums:
 1. Outer wall to provide pressure class rating scheduled.
 2. Provide 2 inch acoustical lining.
 3. Inner wall to be 20 gauge perforated sheet metal.
 4. For air handling unit mixed air plenums, provide LOCK Type 2, Fig. 7-2M.
- J. Ducts Connecting to Wall Louvers:
 1. Provide sheet metal plenum sealing louver area and connecting duct.
 2. Fabricate in accordance with Fig. 6-1.
 3. Fabricate plenum using same material and pressure class as connecting duct.
 4. Paint exterior side of plenum flat black.

2.3 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Round Ducts: Machine made from round spiral lockseam duct.
 1. Manufacture in accordance with SMACNA (DCS).
 2. Fittings: Manufacture at least two gages heavier metal than duct.
 3. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
 4. Machine made from round spiral lockseam duct with light reinforcing corrugations; fittings manufactured of at least two gages heavier metal than duct.
 5. Fittings: Seams shall be fully welded. Tack welding and sealing is not acceptable.
 6. Take-offs: Take-offs shall be conical tee fittings.
 7. Transformations: Transformations shall comply with lengths indicated in United McGill Airflow catalogs (maximum of 24" long)
 8. Manufacturer-Layout Basis: United McGill Corporation
 - a. Other Acceptable Manufacturers:
 - 1) Dixie Sheet Metal Products.
 - 2) Eastern Sheet Metal.
 - 3) Impulse Air.
 - 4) Hamlin Sheet Metal.
 - 5) Lindab, Inc.
 - 6) Monroe Metals.
 - 7) Semco.
- C. Double Wall Insulated Round and Flat Oval Duct: (K-Duct)
 1. Duct dimensions shown are dimensions of perforated liner.

2. Machine made from round spiral lockseam duct with light reinforcing corrugations, galvanized steel outer wall, 1 inch thick fiberglass insulation, perforated galvanized steel inner wall. Refer to 230713.
 3. Fittings: Manufactured with solid inner wall.
 4. Take-offs: Take-offs shall be conical tee fittings.
 5. Transformations: Transformations shall comply with lengths indicated in United McGill Airflow catalogs (maximum of 24" long)
 6. Couplings:
 - a. Below 34 inch I.D. (equivalent round) metal liner shall be joined by slip joints or double, concentric couplings. Outer casings shall have slip fit joints
 - b. Above 34 inch I.D. metal liner shall have separate couplings, and outer casing shall be joined by angle ring flanged connections
 7. Manufacturer-Layout Basis: United McGill Corporation
 - a. Other Acceptable Manufacturers:
 - 1) Dixie Sheet Metal Products.
 - 2) Eastern Sheet Metal.
 - 3) Impulse Air.
 - 4) Hamlin Sheet Metal.
 - 5) Lindab, Inc.
 - 6) Monroe Metals.
 - 7) Semco.
- D. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 2. Minimum R value:6.
 3. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
 4. Maximum Velocity: 4000 fpm.
 5. Temperature Range: -20 degrees F to 210 degrees F.
 6. Manufacturers:
 - a. Atco Rubber Products, Inc; Model UPC-037: www.atcoflex.com.
 - b. Flexible Technologies Group-Thermafex, Inc; Model M-KE: www.thermafex.net
 - c. Flexmaster USA; Model Type 3M: www.flexmasterusa.com.
 - d. Wiremold, Inc; Model WK: www.wiremold.com.
- E. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
- F. Exposed Spiral Duct:
1. Exposed round duct shall be Machine made from round spiral lockseam duct with light reinforcing corrugations with fittings manufactured of at least two gages heavier metal than duct.
 2. Size duct lengths to minimize joint connections. All seams shall be fully welded.
 3. Spiral seams shall be aligned at duct connections. Provide ribbed fitting elbows to match the appearance of the ribbed spiral duct.
 4. Provide factory welded conical manifold taps. All taps on a single duct section shall be aligned unless otherwise noted.

5. Provide Keating coupling or Spiralmate round duct connector for duct sizes up to 48-inch diameter.
6. Duct sizes larger than 48-inch diameter shall be connected with angle rings with bolts.
7. Duct finish shall be mill phosphatized for field painting. Welds shall be ground smooth.
8. Protect duct from physical damage during shipping and storage. Provide protective covering of corrugated or bubble pack wrapping material.

2.4 FUME HOOD EXHAUST

- A. General: Stainless Steel duct from fume hoods, snorkels, and other fume removal devices to connection with the manifolded fume exhaust ductwork, unless noted otherwise. Stainless Steel duct for any fume exhaust ductwork exposed above the roof. Round Ductwork shall conform to SMACNA Round Industrial Duct Construction Standards, 2nd Edition.
- B. No screws or rivets shall be used to fasten duct together.
- C. Round Duct:
 1. Material: 18 gauge type 316 stainless steel
 2. Joints:
 - a. Joints above roof or outside of building shall be welded: Butt, socket or offset joint, figure 15-2.
 - b. Joints inside building may be either butt welded or Van Stone (Figure 15-5)
 - c. Provide flange connections to equipment.
- D. Fittings shall have centerline radius of 1.5 times the duct diameter with 5 gore 90 and 60 elbows and 3 gore 45 and 30 elbows.
- E. Rectangular Duct: 16 gauge type 316 stainless steel butt-welded construction, negative 4" pressure classification. Reinforce in accordance with SMACNA Industrial Duct Construction Standards.
- F. Grind welds to be smooth with adjacent material and polish
- G. Flanged connections shall have acid resistant gaskets.
- H. Converging Duct Branches: Branch duct shall connect to the main at an angle of 30 degrees from trunk in the direction of airflow in the main duct.
- I. Round Manual Volume Dampers: Figure No. 2-14.C, type 304 stainless steel with locking quadrant.
- J. Duct below ceilings shall be satin brushed finish with longitudinal joint against wall and stainless steel hangers.

2.5 FABRICATED HOODS

- A. Heat Removal Canopy: Fabricate hoods of 18 gauge, minimum, type 304 stainless steel with #4 finish. Assemble hoods with no exposed fasteners, using liquid tight welds. Ground down and smooth and polish welds. Utilize S.S. angles for hood reinforcing and hem all raw edges. Provide a full perimeter welded condensate gutter with stainless steel drain fitting. Suspend from structure with threaded rods with top of hood at ceiling.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Duct sizes for lined duct are net metal and include allowance for liner. For unlined duct, sizes are inside clear dimensions.
- E. Duct sizes for runouts to grilles, registers and diffusers shall match the size of the device unless otherwise noted.
- F. Duct Cleanliness level: Intermediate Level in accordance with SMACNA Duct Cleanliness for New Construction Guidelines.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Provide minimum 24 inch wide by 48 inch high access door in field fabricated mixing plenums of same construction as the mixing plenums.
- J. Use double nuts and lock washers on threaded rod supports.
- K. Seal all transverse joints in metal supply, exhaust and return ducts.
 - 1. Class B seal for pressure class less than 4 in. wg.
- L. Exposed Round & flat oval duct in finished spaces: Size duct lengths to minimize joints. Align spiral seams at joints. Install longitudinal and transverse joints in least visible locations. Apply sealer to female fitting and assemble where sealer is not visible.
- M. Connect diffusers to concealed low pressure ducts with 5 feet maximum length of flexible duct held in place with metal clamp. All flexible duct connections to diffusers and metal

ducts shall be made by coating interior of the duct to a depth of 2" with adhesive, and secured in place over the collar with a stainless steel quick release clamp.

- N. Patch Plates/ Duct Cap: Provide where openings in existing ducts are closed. Plate shall be same material as duct being patched and one gauge heavier than scheduled for the duct size and pressure class at the patched location. Secure with sheet metal screws 6 inches maximum on center with a minimum of two screws for each side.

3.2 SCHEDULES

A. Ductwork Material:

1. Low Pressure Supply: Galvanized Steel.
2. Low Pressure Dehumidified Outside Air Supply: Galvanized Steel.
3. Return and Relief: Galvanized Steel.
4. General Exhaust: Galvanized Steel.
5. Outside Air Intake: Galvanized Steel.
6. Louver Plenums: Galvanized Steel.

B. Ductwork Pressure Class:

1. Supply System: 2 inch.
2. Dehumidified Outside Air Supply System: 2 inch.
3. Return and Relief: 2 inch.
4. General Exhaust: 2 inch negative.
5. Mixing Plenums: 2 inch.
6. Outside Air Intake: 2 inch negative.

END OF SECTION 23 3100

SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Backdraft dampers - metal.
- B. Combination fire and smoke dampers.
- C. Duct access doors.
- D. Duct test holes.
- E. Fire dampers.
- F. Flexible duct connections.
- G. Smoke dampers.
- H. Volume control dampers.

1.2 RELATED REQUIREMENTS

- A. Section - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- B. Section 23 3100 - HVAC DUCTS AND CASINGS.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- C. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- D. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- E. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers and duct access doors. Include electrical characteristics and connection requirements.

- C. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Fusible Links: One of each type and size.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 BACKDRAFT DAMPERS - METAL

- A. Manufacturers: Ruskin BD2A2.
- B. Other acceptable manufacturers offering equivalent products: Arrow, American Warming and Ventilating BD-, Cesco , Greenheck, Louvers and Dampers, Nailor Industries, National Controlled Air, Shipman BD-, Pottorff.
- C. Minimum rated spot velocity: 2500 FPM
- D. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- E. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS (SCD/FD)

- A. Manufacturers: Air Balance FA1250, Greenheck FSD-33, National Controlled Air FSD-AF, Ruskin FSD60.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: UL Class I combination type fire/smoke damper. Fabricate with 16 gage galvanized steel frame and air foil type blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

- E. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft.
- F. Damper shall operate closed upon signal of smoke detection, testing, or power failure, with automatic reset to the open position. Damper shall automatically close with a controlled closure release device and lock when temperatures in excess of 165 F are detected. Instantaneous damper closure is not acceptable.

2.3 DUCT ACCESS DOORS(AP)

- A. Manufacturer: Cesco Model *AD.
- B. Other acceptable manufacturers offering equivalent products: Airstream, Flexmaster Inspector Series, Nailor Industries Model 0800, National Controlled Air ADR, Prefco, Ruskin, Ventlok, Pottorff.
- C. Fabrication:
 - 1. Factory fabricated in accordance with SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible, Figures 7-2, 7-3 and as indicated.
 - 2. Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices.
 - 3. Install minimum 1 inch thick insulation with sheet metal cover for insulated ducts.
 - 4. Access doors up to 2 inch pressure class:
 - a. Less Than 12 inches Square: Secure with sash locks.
 - b. Up to 18 inches Square: Provide two hinges and two sash locks.
 - c. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
 - d. Larger Sizes: Provide an additional hinge.
 - 5. Fabricate access doors over 2 inch pressure class in accordance with Figure 7-2.
- D. Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FIRE DAMPERS (FD)

- A. Manufacturer: Ruskin.
- B. Other acceptable manufacturers offering equivalent products: Advanced Air, Inc., Air Balance, Air Control Products, Airstream, American Warming and Ventilating, Cesco,

Greenheck, Louvers and Dampers, Nailor Industries, National Controlled Air, Pacific Air Products, Phillips, Safe-Aire, Shipman, United, Ventco, Pottorff.

- C. Fabricate in accordance with NFPA 90A and UL 555 for dynamic systems, and as indicated.
- D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations.
- E. Fusible Links: UL 33, separate at 165 degrees F with adjustable link straps for combination fire/balancing dampers.
- F. Dampers shall be Type 'A' with breakaway connections, same size as duct unless otherwise noted. Net damper opening of low resistance type 'B' dampers in retracted position shall not be less than 90% of cross sectional area of attached duct.
- G. Dampers in medium pressure ducts shall be Type 'C' with non-breakaway connections and sleeve gauge listed for application .
- H. Dampers installed in supply outlet collars shall not interfere with the air distribution of the outlets.
- I. Multiple Fire Damper Assemblies (Vertical Installations; Allowed Only for Sizes Exceeding 48 inches in Length or Width): Fire dampers assembled together to form protection for a single opening shall be provided with steel mullion(s) meeting the requirements of UL 555 Standard for Safety Fire Dampers and Ceiling Dampers.

2.6 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible, Figures 7-8 and 7-9, and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
- C. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - 1. Net Fabric Width: Approximately 6 inches wide.
 - 2. Metal: 3 inches wide, 24 gage, 0.0239 inch thick galvanized steel.

2.7 SMOKE DAMPERS (SCD)

- A. Rectangular Damper Manufacturer: Ruskin SD36.
- B. Other acceptable manufacturers offering equivalent products: Air Balance S2250A, Greenheck SMD-22, Nailor Industries 1211, National Controlled Air SSD-3V-57, Pottorff.
- C. Round Damper Manufacturers: Ruskin SDRS-25, National Controlled Air SSD-3V-RD, Air Balance, S2250C, Pottorff.
- D. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

- E. Maximum Differential Pressure: 4 inches W.G.
- F. Maximum system velocity: 2000 FPM.
- G. Dampers: UL Class II multiple blade type smoke damper, silicone blade edge seals, stainless steel blade end seals, stainless steel or bronze sleeve type bearings, normally closed with sleeve and electric operator.

2.8 VOLUME CONTROL DAMPERS (MVD).

- A. Manufacturer: Ruskin MD35.
- B. Other acceptable manufacturers offering equivalent products: Airstream, Arrow, Greenheck, Nailor Industries, National Controlled Air, Prefco, Pottorff.
- C. Single Blade Dampers: Figure 7-4. Fabricate for duct sizes up to 6 x 30 inch.
- D. Multi-Blade Damper: Figure 7-5. Fabricate of opposed blade pattern with maximum blade sizes 8 x 48 inch long. Assemble center and edge crimped blades in galvanized channel frame with suitable hardware; 16 gauge, minimum, steel channel frame with blade stops top and bottom; 16 gauge steel blades with formed edge groove to have 3/8 inch interlock between adjacent blades, with 1/2 inch diameter cadmium plated shaft extended 6 inches beyond frame and blade linkage.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- F. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.9 MISCELLANEOUS PRODUCTS

- A. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
 - 1. Thickness: 2 mils.
 - 2. High tack water based adhesive.
 - 3. UV stable light blue color.
 - 4. Elongation Before Break: 325 percent, minimum.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA 1966. Refer to Section 23 3100 for duct construction and pressure class.

- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Duct Access Doors:
 - 1. Provide duct access doors for inspection and cleaning before airflow measuring stations, automatic dampers, combination fire and smoke dampers, fire dampers, and smoke dampers, controls devices, and elsewhere as indicated. Provide access panels in the terminal units or ductwork to access heating coils and elsewhere as indicated for service access or cleaning access.
 - 2. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Label access doors as required by NFPA 90A.
- E. Provide duct test holes where indicated and required for testing and balancing purposes.
- F. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- G. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
- H. Demonstrate re-setting of fire dampers to Owner's representative.
- I. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. Refer to Section 23 0548.
 - 1. Do not install on air handling units with factory flexible connections on fan.
 - 2. Do not install on curb mounted fans .
- J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- K. Volume Control Dampers:
 - 1. Install where shown on drawings or required by details.
 - 2. Lock all volume control dampers in the full open position for adjustment by the TAB agency.

END OF SECTION 23 3300

SECTION 23 3413 - AXIAL HVAC FANS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Propeller fans.
- B. Motors and drives.
- C. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 23 0513 - MOTORS FOR HVAC EQUIPMENT.
- B. Section 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.
- C. Section 23 0800 - Commissioning of HVAC Systems.
- D. Section 23 0913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.
- E. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook; 2010.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2007.
- C. NEMA MG 1 - Motors and Generators; 2014.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data on axial fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

- E. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.5 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 23 0510 - General Mechanical Requirements for delivery, storage and protection requirements.
- B. Protect motors, shafts, and bearings from weather and construction dust.

PART 2 PRODUCTS

2.1 PROPELLER FANS (PWF)

- A. Manufacturers (Direct Drive): Acme F, Breidert SDWA, Cook AWD, Greenheck SE, Penn P.
- B. Impeller: Shaped steel or steel reinforced aluminum blade with heavy hubs, statically and dynamically balanced, keyed and locked to shaft, directly connected to motor .
- C. Frame: One piece, square steel with die formed venturi orifice, mounting flanges and supports, with baked enamel finish.
- D. Accessories:
 - 1. Provide a unit mounted, 130V rated, specification grade, motor rated disconnect switch in Nema housing for fans with single phase motors unless noted otherwise. Provide NEMA 1 housing in interior locations and NEMA 3R in exterior locations.
 - 2. Backdraft Damper: Multiple blade with offset hinge pin, blades linked.
 - 3. Safety Screens: Expanded galvanized metal over inlet, motor, drive; to comply with OSHA regulations.
 - 4. Controller: Solid-state speed controller for direct drive fans,

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install with resilient mountings and with flexible electrical leads; refer to Section 23 0548.
- C. Provide safety screen where inlet or outlet is exposed.
- D. Provide backdraft dampers on discharge of exhaust fans and as indicated.

3.2 STARTING EQUIPMENT

- A. Adjust for proper operation within manufacturer's published tolerances.
- B. Demonstrate proper operation of equipment to Owner 's designated representative.

3.3 COMMISSIONING TESTS

- A. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.
- B. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.4 SCHEDULES

- A. Refer to Schedule on Drawings

END OF SECTION 23 3413

SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Laboratory and fume exhaust.
- B. Utility fans.

1.2 RELATED REQUIREMENTS

- A. Section 23 0513 - MOTORS FOR HVAC EQUIPMENT.
- B. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; <http://www.amca.org/certified/search/company.aspx>.
- B. AMCA 99 - Standards Handbook; 2010.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2007.
- E. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/certified/search/company.aspx>.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.
- H. NEMA MG 1 - Motors and Generators; 2014.
- I. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements for submittal procedures.

- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Fan Belts: One set for each individual fan.

1.5 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Refer to Section 23 0510 - General HVAC Requirements for delivery, storage and protection requirements.
- B. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 FIELD CONDITIONS

- A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- D. Fabrication: Conform to AMCA 99.
- E. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

- F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.2 FUME EXHAUST FAN(FEF)

- A. Manufacturers: Aerovent, PennBarry, Buffalo, Cook, Greenheck; New York Blower, Peerless TwinCity.
- B. Fan Unit: V-belt or Direct Driven as indicated, with wheel, housing and resilient mounted motor with motor and drive.
- C. Wheel and Inlet
 - 1. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and back plate; cast iron or cast steel hub riveted to back plate and keyed to shaft with set screws.
- D. Housing
 - 1. Heavy gage steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.
 - 2. Factory finish before assembly to manufacturer's standard.
- E. Motor: ECM type motor with speed controller; Refer to Section 23 0513 .
- F. Bearings and Drives
 - 1. Bearings: Heavy duty pillow block type, self-greasing ball bearings, with ABMA 9 Life at 50,000 hours.
 - 2. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
 - 3. Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Variable and adjustable pitch sheaves for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid Fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
 - 4. Belt Guard: Fabricate to SMACNA (DCS) Standard; 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 5. Direct Drive Units: Provide solid state speed controller on direct driven fans.
- G. Belt and Weather Cover: Removable Steel Cover with factory finish, 0.106 inch thick, minimum. Secure to fan or fan supports without short circuiting vibration isolation, with provision for ventilation of motor with cover in place.
- H. Corrosion Resistance: An approximately 7-10 mil Baked Phenolic coating of the impeller wheel and housing, with UV inhibitor. Coating shall resist attack by inorganic acid, alkalies, metal etchants and solvents and be applied on sandblasted metal.

I. Accessories

1. Flexible Connections: Chemical resistant, 1/8" thick minimum, flexible EPDM secured with flanges on round and rectangular ducts. Proco Products Series 500. Refer to installation Detail.
2. Vertical Stack Head: Stack head shall be fabricated from type 316 Stainless steel (all fume fans) in accordance with ACGIH Industrial Ventilation, 1981, Figure 6-24 with dimension 'D' being the fan inlet diameter with a discharge ten feet above the roof minimum
3. Scroll Drain: 1/2 inch steel pipe coupling welded to low point of fan scroll.
4. Access Doors: Shaped to conform to scroll, with quick opening latches and gaskets.

PART 3 EXECUTION

3.1 PREPARATION

- A. Seal all duct roof penetrations at roof structure air-tight.
- B. Ensure exhaust duct is clean and free of debris.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide a second adjustable sheave to place belt at mid-position of sheave at RPM required for final air balance.

3.3 STARTING EQUIPMENT

- A. Adjust for proper operation within manufacturer's published tolerances.
- B. Demonstrate proper operation of equipment to Owner 's designated representative.

3.4 ADJUSTING

- A. Adjust belt alignment and tension for smooth operation.

3.5 SCHEDULES

- A. Refer to Schedule on Drawings.

END OF SECTION 23 3423

SECTION 23 3700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers
- B. Registers/grilles
- C. Louvers

1.2 RELATED REQUIREMENTS

- A. Section 09 9000 - Painting and Coating: Painting of ducts visible behind outlets and inlets.

1.3 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012.
- B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Inlets; 2006 (R2011).
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.5 WARRANTY

- A. See Section 01 7700 - Closeout Procedures, for additional warranty requirements.
- B. Louver Finishes - Fluoropolymer finish shall remain free of checking, cracking, peeling, chalking, or color fade for a minimum period of five years from the date of Material Completion.

PART 2 PRODUCTS

2.1 RECTANGULAR LOUVERED FACE CEILING DIFFUSERS (RLF)

- A. Manufacturer: Titus Model TDC.
- B. Other acceptable manufacturers offering equivalent products:
 - 1. Nailor Model 6500.
 - 2. Price Model SMD.
 - 3. Krueger Model SH.
 - 4. Tuttle & Bailey 'MSR'.
- C. Type: Square and rectangular, multi-louvered diffuser with flush face, round neck duct connection and rod mounted air pattern deflectors as required by pattern indicated on floor plans.
- D. Frame: Surface Mount, Snap-In, Inverted T-Bar(Lay-in), or Spline type to match ceiling. Refer to schedule on Drawings. A rapid mount plaster sub-frame may be substituted to convert a Lay-in frame for use in a sheetrock or plaster ceiling provided that the diffuser & frame match the face size specified.
- E. Fabrication: Diffusers shall be constructed of 24 gauge steel or 0.04 aluminum and shall have a finish as scheduled.
- F. Dimensions:
 - 1. The diffuser neck shall have a minimum 1 1/8-inch depth for duct connection.
- G. Accessories:
 - 1. Radial opposed blade damper adjustable from diffuser face as scheduled on drawings.
 - 2. Provide 24" x 24" or 12" x 12" module for ceiling diffusers in a lay-in ceiling as scheduled.

2.2 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES (CGC)

- A. Manufacturer: Titus Model 50F
- B. Other acceptable manufacturers offering equivalent products:
 - 1. Anemostat GC5
 - 2. Price 80
 - 3. Krueger RA
 - 4. Nailor 51EC.
 - 5. Tuttle & Bailey CRE500
- C. Type: Fixed grilles of 1/2 x 1/2 x 1/2 inch eggcrate grid core.
- D. Fabrication: Aluminum with factory off-white enamel finish.
- E. Frame: 1-1/4 inch margin with countersunk screw mounting.

- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.3 CEILING SLOT DIFFUSERS (CSD1)

- A. Manufacturer: Titus Model ML-*(supply) or MLR-*(return)
- B. Other acceptable manufacturers offering equivalent products:
 - 1. Anemostat SLAD
 - 2. Price SDS
 - 3. Krueger 1900-B
 - 4. MetalAire
 - 5. Tuttle & Bailey 6*00F
- C. Type: Number and width of slots and length as scheduled and with adjustable vanes for left, right, or vertical discharge .
- D. Fabrication: Aluminum extrusions with frame and border type as specified. Provide factory finish of clear lacquer, off-white enamel or baked enamel (color to be selected) as scheduled on drawings. Adjustable vanes shall be finished flat black.
- E. Frame for mounting in sheetrock Ceilings 1-1/4 inch margin with concealed mounting and gasket.
- F. Frame for mounting in inverted T-bar Ceilings 1-1/4 inch margin with support clips for T bar mounting and gasket.
- G. Air Plenum: Integral, galvanized steel, insulated. Fabricate to lengths indicated in schedule.
- H. Accessories:
 - 1. Provide hanger brackets, spring clips, alignment pins for continuous appearance of multiple sections, end caps and mitered corners to match diffuser type specified and arrangement shown.
 - 2. Provide adjustable inlet damper where scheduled on Drawings.

2.4 WALL SUPPLY REGISTERS/GRILLES (WSAR):

- A. Manufacturer: Titus Model 300RS.
- B. Other acceptable manufacturers offering equivalent products:
 - 1. Anemostat .
 - 2. Price 520D.
 - 3. Krueger 620/F/D.
 - 4. MetalAire Y4004S.
 - 5. Tuttle & Bailey T647.

- C. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection.
- D. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- E. Fabrication: Steel with 20 gage, 0.0359 inch minimum frames and 22 gage, 0.0299 inch minimum blades, steel and aluminum with 20 gage, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish as scheduled on Drawings.
- F. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.5 WALL EXHAUST AND RETURN REGISTERS/GRILLES (WRAG)

- A. Manufacturer: Titus Model 350RL.
- B. Other acceptable manufacturers offering equivalent products:
 - 1. Anemostat .
 - 2. Krueger.
 - 3. MetalAire -SRH .
 - 4. Tuttle & Bailey T70D.
- C. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with 35 degree, minimum fixed blade deflection, horizontal face.
- D. Frame: 1-1/4 inch margin with countersunk screw mounting.
- E. Fabrication: Steel and aluminum, with factory baked enamel finish as scheduled on Drawings.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.6 LOUVERS-ALUMINUM-DRAINABLE BLADE STYLE

- A. Manufacturer: Ruskin Model ELF-6375DX.
- B. Other acceptable manufacturers offering equivalent products:
 - 1. American Warming & Ventilating LE-33.
 - 2. Air Balance .
 - 3. Arrow EA-615-D.
 - 4. Dowco DW-6.
 - 5. Greenheck ESD-603.
 - 6. Industrial Louvers 653.
 - 7. Louvers & Dampers IEL-6.
 - 8. Shipman LE-33.
 - 9. Tuttle & Bailey DB-645.

- C. Type: 6 inch deep with blades on 45 degree slope, drainable blade with gutter, heavy channel frame, 19 gauge birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.
- D. Fabrication: 12 gage thick extruded aluminum, welded assembly, with factory Kynar fluoropolymer spray finish, color to be selected by Design Professional.
- E. Mullions: Provide hidden or exposed mullions to support blades as shown on architectural elevations.
- F. Mounting: Furnish with channel frame and interior flat flange for installation.
- G. Insulated Blank-Off Panels:
 - 1. Fabricate louver blank-off panels of materials and sizes indicated and to comply with the following requirements:
 - a. Finish: Match finish applied to louver with respect to coating type, except for color, which shall be flat black.
 - b. Attach blank-off panels to back of louver frames with stainless-steel sheet-metal screws.
 - 2. Blank-Off Panels: Laminated metal-faced panels consisting of insulating core surfaced on back and front with metal sheets, complying with the following requirements:
 - a. Thickness: 2 inches (50 mm).
 - b. Metal Facing Sheets: Aluminum sheet, 0.032 inch (0.81 mm) thick.
 - c. Insulating Core: Unfaced, rigid, glass-fiberboard insulation complying with ASTM C612, Class 1 and Class 2.
 - d. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames 0.081 inch (2.06 mm) thick, with corners mitered and with same finish as panels.
 - e. Seal perimeter joints between panel faces and louver frames with 1/8 inch by 1 inch (3.2 mm by 25 mm) polyvinyl chloride compression gaskets.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with air tight connection.
- D. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9000.
- E. Ceiling Slot Diffusers: Cut diffuser to length to fit Reflected Ceiling Plans without marring finish. Install multiple section diffusers with alignment pins and maintain linear alignment. Provide sheetmetal blanks on inactive portions of diffuser with flat black finish on diffuser side. Install end caps and mitered corners and other accessories shown.

3.2 AIR OUTLET AND INLET SCHEDULE

- A. Refer to Schedule on Drawings.

END OF SECTION 23 3700

SECTION 23 4000 - HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disposable, extended area panel filters.
- B. Disposable panel filters.

1.2 RELATED SECTIONS

- A. Section 23 0510 - General Mechanical Requirements - Space Conditioning during construction and building flushout.
- B. Section 23 7425 : Filters for Filter Sections specified with Air Handling Equipment.
- C. Section 23 8132 : Filters for Filter Sections specified with Heat Pump Units.

1.3 REFERENCE STANDARDS

- A. AHRI 850 - Performance Rating of Commercial and Industrial Air Filter Equipment; 2004.
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2012, with 2015 amendments.
- C. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.
- E. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

2. Provide filters whenever any system is operated during construction. Refer to Section 23 05 10.
3. For every system requiring filters:
 - a. Provide and install one set of new disposable panel filters at Substantial Completion.
 - b. Provide one set of spare disposable panel filters at Substantial Completion.

1.5 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 DISPOSABLE, EXTENDED AREA PANEL FILTERS (EAPF)

- A. Manufacturers: American Air Filter AM-AIR, Air Guard, CamFil-Farr 30/30, Purolator.
- B. Media: UL 900 Class 2, pleated, lofted, non-woven, reinforced cotton and synthetic fabric; supported and bonded to welded wire grid .
 1. Frame: Cardboard.
 2. Nominal size: 24 x 24 inches.
 3. Nominal thickness: 2 inches or 4 inches as specified.
- C. Minimum Efficiency Reporting Value MERV - 11, when tested in accordance with ASHRAE 52.2.
- D. Initial resistance at 500 FPM face velocity: 0.20 inch WG.
- E. Recommended final resistance: 0.9 inch WG.

2.2 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
 1. Nominal Size: Selected to fit filter frames of packaged heat pump units.
 2. Thickness: 1 inch.
- B. Performance Rating:
 1. Face Velocity: 500 FPM.
 2. Initial Resistance: 0.10 inch WG.
 3. Recommended Final Resistance: 0.50 inches WG.
- C. Casing: Cardboard frame.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.
- D. Do not install second stage medium or high efficiency filters until project is complete and ready for balancing.
- E. Provide 20 gauge sheetmetal safing to prevent bypass airflow around filters.

3.2 SCHEDULES

- A. Provide filter media for Air Handling systems and equipment specified in Sections 23 7425 , 23 8132.

END OF SECTION 23 4000

SECTION 23 5100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured double-wall metal vents for gas fired equipment.

1.2 RELATED REQUIREMENTS

- A. Section 23 0510 - General Mechanical Requirements.
- B. Section 23 5216 - Condensing Heating Boilers.
- C. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2010.
- C. NFPA 54 - National Fuel Gas Code; 2015.
- D. NFPA 211 - Guide for Smoke and Heat Venting; 2013, Including All Amendments.
- E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- F. UL 1738 - Standard for Gas-Burning Appliances.
- G. UL 2221 - Tests of Fire Resistive Duct Enclosure Assemblies ; 2010.
- H. UL 378 - Standard for Draft Equipment; Current Edition, Including All Revisions.
- I. UL 959 - Medium Heat Appliance Factory Built Chimneys; Current Edition, Including All Revisions.

1.4 DEFINITIONS

- A. Chimney: Primarily vertical vent for conducting flue gases to the exterior.
- B. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- C. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.5 SUMMARY

- A. This Section includes the following :
 - 1. Listed factory built double-wall metal gas vent.
 - 2. Mechanical draft system is to sense positive and negative pressure in the venting system.

1.6 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data indicating factory built vents, including dimensional details of components, dimensions and weights, and connection requirements.
 - 2. Draft fan descriptive literature, dimensional diagrams, and electrical diagrams.
 - 3. Control system descriptive literature, dimensional diagrams, and electrical diagrams.
- C. Shop Drawings: Factory prepared shop drawings and vent sizing calculations shall be required as part of the submittal. Submit layout drawings of entire venting system indicating plan view, elevations, sections, details, access locations, and attachments to other work. Indicate duct fittings, particulars such as gages, sizes, joints, and configuration.
- D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
- E. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of documented experience and approved by manufacturer.

1.8 REGULATORY REQUIREMENTS

- A. Conform to applicable code for installation of natural gas burning appliances and equipment.

1.9 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

- B. Provide a ten year warranty for functional failure due to defects in manufacturer's workmanship or material for the boiler venting systems.

PART 2 PRODUCTS

2.1 METAL VENTS AND STACKS FOR CONDENSING BOILERS

- A. Manufacturers:
 - 1. Selkirk; Model PS
 - 2. Other acceptable manufacturers offering equivalent products.
 - a. Heatfab; Model CI Plus Saf-T-Vent
 - b. Metal-Fab; Model Corr/Guard CG.
 - c. Schebler; Model eVent.
- B. Provide double wall metal stacks, tested to UL 1738 and UL listed, for use with building heating equipment, in compliance with NFPA 211.
- C. Fabricate with air space between walls. Construct inner jacket of type AL29-4C stainless steel. Construct outer jacket of Type 430 or 304 stainless steel.
- D. All exterior components shall be fabricated of Type 430 or 304 stainless steel.
- E. Vent assembly shall be designed for a maximum 550°F and pressure of 15" W.C.
- F. Joints: Joints for gas fired appliances shall be sealed with manufacturer supplied bands and sealant.
- G. Accessories, UL labeled:
 - 1. Elbows, tees and drain fittings.
 - 2. Drain caps or inline drains.
 - 3. Vent support assemblies.
 - 4. Wall penetration thimble.
 - 5. Vertical discharge vent caps (where indicated).
 - 6. Wall Discharge: Manufactured open screen horizontal discharge fitting (where indicated).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide venting from boilers to discharge through cap on roof or vents at exterior wall as indicated on drawings.
- C. Install in accordance with NFPA 54.
- D. Install vents with minimum of joints. Align accurately at connections, with internal surfaces smooth.

- E. Support vents from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling.
- F. Pitch breechings with positive slope up from fuel-fired equipment to stack as recommended by the manufacturer.
- G. Anchor vents to building and install fireproof thimbles where required by manufacturer.
- H. Clean vent sections during installation, removing dust and debris.
- I. Pipe drain fitting tapping, full size to floor drain. Provide [two] inch trap at floor drain. Pipe shall be ASTM A 53 Schedule 40, galvanized steel ASME B16.3, malleable iron fittings.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Start-up shall include setting of the appliance drafts and adjustments.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Provide start-up certificate in the format prescribed by the General Conditions.

3.3 DEMONSTRATION, TRAINING AND INSTRUCTIONS

END OF SECTION 23 5100

SECTION 23 5216 - CONDENSING HEATING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Boilers.
- B. Controls and boiler trim.
- C. Hot water connections.
- D. Fuel connection.
- E. Combustion air inlet and exhaust vents.
- F. Boiler Management controls.

1.2 RELATED SECTIONS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 23 0510 - General Mechanical Requirements - Warranty.
- C. Section 23 2114 - Hydronic Specialties.
- D. Section 23 5100 - Breechings, Chimneys, and Stacks.
- E. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- F. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2004 (addendum 2005).
- B. ASME (BPV IV) - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2004.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. NFPA 54 - National Fuel Gas Code; 2012 Edition.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association, 2014.

1.4 SUBMITTALS

- A. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements.
- B. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
- C. Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- E. State of Georgia Certified Inspection of Boilers and Pressure Vessels; Certificate.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- G. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.5 QUALITY ASSURANCE

- A. The boiler shall be installed, tested, adjusted, and placed into operation under the supervision of authorized personnel of the boiler manufacturer.
- B. Boilers using gas fuels shall be AGA approved and rated.
- C. Low pressure heating boilers shall be designed and tested according to the ASME boiler and pressure code, Section IV. The boilers shall be ASME stamped.
- D. Safety relief valves shall be sized by the boiler manufacturer in accordance with ASME requirements and shall be provided with the boiler.

1.6 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 for internal wiring of factory wired equipment.
- B. Conform to ASME (BPV IV) and ANSI Z21.13 for boiler construction.
- C. Units: AGA certified.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment" as suitable for the purpose specified and indicated.
- E. State of Georgia Certified Inspection of Boilers and Pressure Vessels

1. Contractor shall obtain an installation permit and upon completion of the installation shall have each boiler inspected in accordance with Georgia Law by a State of Georgia certified inspector.
2. Contractor shall obtain for Owner a satisfactory "Report of Inspection". Include a copy in the project closing documents and mount a copy of the report in an accessible frame in the boiler room within sight of each respective boiler. Date of the Inspection shall be within 30 days of the Substantial Completion.
3. Additional State of Georgia Information:
www.oci.ga.gov/FireMarshal/SafetyEngineering.aspx
4. Address: Georgia Department of Insurance, Safety Engineering, 2 Martin Luther King Jr., Dr., Atlanta, GA 30334, West Tower.
5. The Construction Manager shall pay all fees associated with the permits and inspections.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.8 WARRANTY

- A. Provide a 10 year warranty to include coverage for heat exchangers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Aerco Benchmark BM.
- B. Camus DynaForce.
- C. Lochinvar Corporation; Model Crest.
- D. Patterson-Kelley MACH Series.
- E. Cleaver Brooks; Model ClearFire-C.

2.2 MANUFACTURED UNITS

- A. The boiler shall be of the packaged, factory fabricated and assembled type complete with burners, fuel train, controls, heat exchanger, insulation, housing, relief valve, and items required for a ready-to-operate installation. The boiler shall a modulating, condensing design for firing natural gas and shall be power vented if required.
- B. The boiler shall be a sealed combustion system, taking only outside air for combustion with plastic schedule 80 PVC pipe. The exhaust vent shall be piped with an insulated double-wall flue-gas vent, suitable for condensing equipment producing flue gas temperatures not exceeding 550 deg. F.

- C. The operation of the boiler shall be in a closed loop pressurized system. The boiler construction shall be in accordance with ANSI Standard for Gas Fired Low-Pressure Steam and Hot Water Boilers, ANSI Z21.13b-1994.
- D. The heater should operate at an a minimum acceptable fuel-to-water efficiency of 93% at a return EWT of 100°F, and 87% at 160°F EWT when operating at the full rated input capacity of the boiler.

2.3 FABRICATION

- A. The pressure vessel, burner, and heat exchanger components shall be fabricated of carbon steel, type 316L stainless steel, or cast aluminum.
- B. Jacket: Plastic or galvanized steel with factory applied baked enamel, insulated with foil faced fiberglass insulation.

2.4 FUEL BURNING SYSTEM

- A. A combustion control system shall be furnished which provides a minimum turndown ratio of 4:1 per over the input range from high to low fire. Firing rate shall be controlled by a continuous 4-20mA analog signal to a modulation motor.
- B. The burner shall produce less than 30 ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.1 for boilers and water heaters greater than 2 MBTU's and less than 5 MBTUs.
- C. Safety Controls: Provide sensing devices to prove combustion and air safety switch to prevent operation unless sufficient pre-purge air is assured.
- D. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
- E. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

2.5 TRIM AND ACCESSORIES

- A. ASME rated pressure relief valve set at 60 psi.
- B. Low water cut-off, and secondary probe type low water cut-off to automatically prevent burner operation when water falls below safe level.
- C. Condensate drain kit with condensate trap and condensate neutralization kit to include hose for draining the flue gas condensate.

2.6 CONTROLS

- A. Operating Controls: Pre-wired, factory assembled electric controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements. Electrical power supply shall be 120 volts, 60 cycle, single phase.
- B. The supply temperature and setpoint temperature shall be displayed at all times by the operating temperature control.
- C. High limit temperature controller with automatic reset for burner to prevent boiler water temperature from exceeding safe system temperature.
- D. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD 1.
- E. Boiler Management System:
 - 1. The boiler manufacturer shall supply as part of the boiler package a completely integrated boiler management system to control all operation and energy input of the multiple boiler heating plant. The system shall be comprised of a microprocessor based control to communicate with the standalone boiler control panels. The controller shall have the ability to operate all boilers installed in the plant, and shall be interfaced with the DDC - Building Automation System (BAS).
 - 2. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The system shall control the boiler outlet header temperature within +2 °F. The controller shall be a PID type controller implementing control algorithms for accurate temperature control with excellent variable load response. The controller shall provide contact closure for auxiliary equipment such as system heating pumps.
 - 3. Non-volatile memory backup of all control parameters shall be internally provided as standard. The controller will automatically balance the sequence of operating time on each boiler by a first-on first-off mode and provide for setback and remote alarm contacts. Connection between central boiler control system and individual boilers shall be twisted pair low voltage wiring.

2.7 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall be served by a single-point field power connection to the boiler.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify service and code required clearances.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install boiler on concrete housekeeping base, sized minimum 4 inches larger than boiler base. Refer to Section 03 3000.
- C. Provide connection of natural gas service in accordance with NFPA 54 (AGA Z223.1).
- D. Provide piping connections and accessories as indicated; refer to Section 23 2114.
- E. Pipe relief valves to nearest floor drain.
- F. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.
- G. Boiler Condensate and Drain Piping: ASTM A 53/A 53M, Schedule 40 galvanized.
 - 1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
- H. Provide for connection to electrical service. Refer to Section 26 2717.
- I. Install control wiring to field-mounted electrical devices.
- J. Boiler Management System: Install controls and wiring external to boilers in accordance with manufacturer's recommendations and in accordance with Section 26 2717.
- K. Combustion Air Intake:
 - 1. Install combustion-air intake piping to exterior in accordance with manufacturer's recommendations.
 - 2. Schedule 80 PVC pipe. Terminate in accordance with manufacturer's recommendations.
- L. Boiler Venting:
 - 1. Install equipment combustion venting to exterior.
 - 2. Connect venting full size to boiler connections.
 - 3. Refer to Section 23 5100 - Breechings, Chimneys, and Stacks.

3.3 STARTING EQUIPMENT

- A. Start no equipment or systems until all prefunctional checklists have been completed, signed, and sent to the CM for approval.
- B. Provide services of the manufacturer's factory trained representative to prepare and start-up boilers, calibrate controls, test units, and inspect the equipment/venting installation.
- C. Adjust for proper operation within manufacturer's published tolerances.
- D. Check all safety controls.
- E. Provide a start-up certificate in accordance with the General Conditions.

3.4 CLOSEOUT ACTIVITIES

- A. Provide services of factory trained representative to instruct the Owner on operation and maintenance of units.
- B. Demonstrate proper operation of equipment to the Owner 's designated representatives.
- C. Train operating personnel in operation and maintenance of units.

3.5 SCHEDULES

- A. Refer to Schedule on the Drawings.

END OF SECTION 23 5216

SECTION 23 6533 - LIQUID COOLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Liquid cooler.
- B. Controls.
- C. Inside sump.
- D. Circulating pump.

1.2 RELATED REQUIREMENTS

- A. Section 22 0513 - Common Motor Requirements for Plumbing Equipment.
- B. Section 23 0513 - MOTORS FOR HVAC EQUIPMENT.
- C. Section 23 2113 - HYDRONIC PIPING.
- D. Section 23 2123 - HYDRONIC PUMPS.
- E. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; 1990 (Reapproved 2008).
- C. ASME PTC 23 - Atmospheric Water Cooling Equipment; 2003.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.
- C. Shop Drawings: Indicate suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.

- D. Certificates: Certify that liquid cooler performance, based on ASME PTC 23 meet or exceed specified requirements and submit performance curve plotting leaving water temperature against wet bulb temperature.
- E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include cleaning methods and cleaning materials recommended.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Fan Belts: One set, matched, for each unit.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Factory assemble entire unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly.
- B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.6 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide a five year warranty to include coverage for liquid cooler package, fan drive, motor, and pan, casing and cooler coil, labor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Layout Basis: SPX Cooling Technologies/Marley; model: MHF.
- B. Additional acceptable manufacturers:
 - 1. Evapco, Inc; model: ESW4
 - 2. Baltimore Aircoil Company, Inc; model: FXV.

2.2 MANUFACTURED UNITS

- A. Provide outdoor units, factory assembled, sectional, crossflow, vertical discharge, induced draft design, with fan assemblies built into pan and casing.

2.3 COMPONENTS

- A. Pan and Casing: G235 Galvanized steel, minimum 14 gage, 0.0747 inch for casing and 8 gage, 0.1644 inch for reinforcing angles and channels.
- B. Cooler Coil: Steel tubing, air tested under water to 350 psi, sloped to ensure drainage, encased in steel framework. Provide cleanable header unit with removable cover plates on header to access tubular coil.
- C. Fans: Multi blade, cast aluminum, axial type, with belt drive, bearings with ABMA STD 9 or ABMA STD 11, L-10 life expectancy at 30,000 hours, with extended grease fittings.
- D. Fan Motors: Single speed (1800/900 rpm) mounted on adjustable steel base for use with variable speed drive. Refer to Section 23 0513.
- E. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed. Fixed pitch sheave for motors 15 hp and under, selected so required rpm is obtained with sheaves set at mid-position. Fixed sheave for 20 hp and over, matched belts. Drive rated minimum 1.5 times nameplate rating of motor. The fan and fan drive assembly for each cell shall be supported by a rigid, galvanized steel structural support that resists misalignment.
- F. Fan Guard: Removable, welded steel rod and wire guard.
- G. Coil: Coil(s) shall consist of fully welded box headers with serpentine tube circuits and shall be hot-dip galvanized after fabrication. The coil(s) shall be designed for free drainages of fluid at shutdown. Minimum design operating pressure shall be 150 psi.
- H. Distribution Section: Polyvinyl chloride piping header and branches with ABS plastic spray nozzles.
- I. Fill: Fill shall be film-type, thermoformed of heavy duty PVC, with louvers and eliminators formed integrally in each fill sheet.
- J. Access: A large galvanized steel, rectangular access door shall be located on both endwalls for entry into the cold water basin and fan plenum area. Access doors shall be a minimum of 24" wide and 42" tall and shall be operable from inside and outside of the fluid cooler.
- K. Drift Eliminators: Two or three pass formed PVC or steel, minimum 24 gage, 0.0239 inch, to limit drift loss to 0.7 percent of total water circulated.
- L. Finish: Electrostatically sprayed thermosetting polymer.
- M. Guardrail/Ladder: The top of the fluid cooler shall be equipped with a guardrail, complete with kneerail and toeboard, designed according to OSHA guidelines and factory welded into sub-assemblies for ease of field installation. The guardrail assembly shall be hot dipped galvanized after welding and capable of withstanding a 200 lb. concentrated live load in any direction. Posts shall be spaced on centers of 8'-0" or less. An aluminum ladder with I-beam side rails shall be permanently attached to the endwall casing of the tower, rising from the base of the fluid cooler to the top of the guardrail.

2.4 INSIDE SUMP

- A. Pan and Casing: G235 Galvanized steel, minimum 14 gage, 0.0747 inch for casing and 8 gage, 0.1644 inch for reinforcing angles and channels with lift out steel strainer.
- B. Finish: Electrostatically sprayed thermosetting polymer.
- C. Float Valves: Brass or bronze balanced piston type make-up valve with plastic or copper float.
- D. Water Level Control: water level control system including a NEMA 4X control panel, water level probes and probe stilling chamber. The control system shall monitor the water level in the cold-water basin to determine level events used for cold-water make-up, high and low alarms and/or pump shut down. The control panel shall use electromechanical relays providing power for the make-up solenoid and electrical contacts for alarm and pump shutdown control circuits.

2.5 CIRCULATING PUMP

- A. Pump: Close coupled, bronze fitted, centrifugal pump with mechanical seal, mounted on piping.
- B. Pump Control: Pan mounted immersion thermostat set at 140 degrees F.
- C. Pump motor: Single speed (1800/900 rpm) open drip proof mounted on pump body. Refer to Section 22 0513.
- D. Performance:
 - 1. Motor: Maximum 10 hp.

2.6 TOWER BASIN CLEANING SYSTEM

- A. Manufacturers (Tower and cleaning system supplier shall be by the same local representative for single source responsibility.):
 - 1. PEP Filters.
 - 2. Lakos.
- B. System: Close coupled pump and centrifugal separator pre-piped and pre-wired on skid and field installed sweeper piping in tower(s) with eductor nozzles.
- C. Performance: Design flow 200 gal/min with maximum pump horsepower of 5 HP.
- D. Close Coupled Pump:
 - 1. Type: Horizontal shaft, single stage, close coupled, radially split casing, for 125 psi maximum working pressure.
 - 2. Casing: Cast Iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
 - 3. Impeller: Bronze, fully enclosed, keyed to motor shaft extension.
 - 4. Shaft: Stainless Steel.
 - 5. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.

- E. Separator shall be epoxy coated carbon steel rated for 150 PSIG with automatic purge valve, and NEMA 4X Control panel with disconnect, overloads, and purge timer with manual override.
- F. Sweeper Piping:
 - 1. The cold water basin shall be equipped with factory installed corrosion resistant PVC sweeper piping with plastic nozzles. The sweeper piping system shall be designed to force dirt and debris towards a dedicated drain in the depressed section of the collection basin.
 - 2. PVC: ASTM D 1785, Schedule 80, or ASTM D 2241, SDR 21 or 26.
 - 3. Fittings: ASTM D 2466, or ASTM D 2467, PVC.
 - 4. Joints: Solvent welded.

2.7 ACCESSORIES

- A. Electric Immersion Heaters: In pan suitable to maintain temperature of water in basin at 42 degrees F when outside temperature is 0 degrees F and wind velocity is 15 mph; immersion thermostat and float control to operate heaters on low temperature when pan is filled.
- B. Vibration Limit Switch: A vibration limit switch in a NEMA 4X housing shall be installed on the mechanical equipment support and wired to the shut-down circuit of the fan motor starter or VFD. The purpose of this switch will be to interrupt control power voltage to a safety circuit in the event of excessive vibration causing the starter or VFD equipment to de-energize the motor. It shall be adjust-able for sensitivity and include a means to reset the switch.
- C. Ladder Safety Cage: A heavy-gauge aluminum safety cage welded into subassemblies for ease of field installation shall surround the ladder, extending from a point approximately 7'-0" above the foot of the ladder to the top of the guardrail surrounding the fan deck or platform.
- D. Ladder Extension: Provide a ladder extension for connection to the foot of the ladder. This extension shall be long enough to rise from the roof (grade) level to the base of the fluid cooler.
- E. Plenum Walkway: Provide a factory-installed, heavy gauge steel walkway with safety grip perforations, extending from one cased face access door to the other cased faced access door. This walkway shall be supported by a steel framework, and the top to the walkway shall be at or above the cold water basin overflow level and be equivalent material as the tower basin.
- F. Pump Motor Control Panel: Each cell of the fluid cooler shall be equipped with a UL 508 listed control panel in a NEMA 3R outdoor enclosure designed specifically for fluid cooler applications. The panel shall include a main thermal magnetic circuit breaker disconnect with an external operating handle, lockable in the off position for safety. For spray pump operation use of a full volt-age non-reversing magnetic starter with manual ON and OFF control via a door mounted selector switch shall be provided. Dry status contacts wired to user terminal points indicating typical alarm and status events shall be provided. Two safety circuits for the spray pump, low water cut off preventing a dry run pump and a

pump shut down upon approaching freezing temperatures in the cold water basin shall be provided.

END OF SECTION 23 6533

SECTION 23 7220 - PACKAGED DEDICATED OUTSIDE AIR SYSTEM UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outside Air Ventilation Units.
- B. Unit controls.
- C. Remote panel.
- D. Roof mounting curb and base.

1.2 RELATED SECTIONS

- A. Section 23 0510 - General HVAC Requirements- Housekeeping pads.
- B. Section 23 0513 - Motors for HVAC Equipment.
- C. Section 22 1005 - Plumbing Piping: Equipment drains.

1.3 REFERENCES

- A. AMCA 99 - Standards Handbook; Air Movement and Control Association International, Inc.; 1986.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 1997.
- C. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 1996.
- D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 1990.
- E. ARI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning and Refrigeration Institute; 1995.
- F. ARI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils; 1991.
- G. ARI 430 - Standard for Central-Station Air-Handling Units; 1989.
- H. NEMA MG 1 - Motors and Generators; 1993 (and Revision 1,2,3).
- I. NFPA 70 - National Electrical Code 2011.
- J. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

- K. UL 900 - Standard for Air Filter Units; 1994.

1.4 SYSTEM DESCRIPTION

- A. Packaged unit(s) designed to provide preconditioned outside air to the building.

1.5 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D. Manufacturer's Instructions: Include installation instructions.
- E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- G. Certificate: Provide Manufacturer's Certificate.

1.6 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

- C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.8 WARRANTY

- A. See Section 23 0510 - General HVAC Requirements for additional Warranty requirements.
- B. Provide a five year warranty to include coverage for heat exchanger, energy wheel(s) and compressor(s).

1.9 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Provide one clean set of filters at Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Greenheck; Model RVE.
- B. Acceptable alternative manufacturers:
 - 1. Aeon
 - 2. Daikin
 - 3. JCI
 - 4. Trane

2.2 GENERAL DESCRIPTION

- A. Factory fabricated, exterior air handling units with components scheduled housed within modules for field assembly into an complete air handling system with microprocessor controller.
- B. Configuration: Fabricate with scheduled sections and accessories, including:
 - 1. Fan section(s) with factory installed variable speed drives.
 - 2. Natural gas burner.
 - 3. Hot Gas Reheat Coils.
 - 4. Evaporator Coil(s).
 - 5. Filter(s).
 - 6. Compressor(s).
 - 7. Enthalpy Energy Recovery Wheel with variable speed drive (where scheduled).
 - 8. Condensing section.
 - 9. Operating and safety controls.
- C. Fabrication: Conform to AMCA 99 and ARI 430.

2.3 CASING

- A. Construction: Fabricate each section of welded channel frame with removable panels, double wall construction with connection pieces for field assembly with gasketing between assembled sections.
 - 1. Outside Casing:
 - a. G90 Galvanized Steel: .0396 inch, minimum.
 - 2. Inside Casing:
 - a. G90 Galvanized Steel: Solid, 0.0276 inch thick, minimum .
 - 3. Floor Plate:
 - a. G90 Galvanized Steel: 1.382 inch thick.
- B. Roof: Slope roof to drain without pooling, 1/4 inch per foot minimum slope.
- C. Strength: Provide structure to brace casings for suction pressure of 6 inch wg positive and 4 inch wg negative, with maximum deflection of 1 in 200.
- D. Insulation: Closed cell polyurethane foam.
 - 1. Walls: Minimum 2-inch thick panels with a minimum R-12.5 insulation.
 - 2. Roof: Sloped with an average of 2-inch thick panels with a minimum R-12.5 insulation.
 - 3. Floor: Minimum 3-inch thick with a minimum R-18.8 insulation.
 - 4. Provide thermal breaks on casing, mating joints, structural forms, doors and door frames in all sections and provide test data or a 20 year guarantee that the casing and doors will not condense moisture when the air temperature leaving cooling coil is 53 DB and the temperature on the unit exterior is 83DB/76WB.
- E. Alternate Insulation: Neoprene coated, glass fiber, applied to internal surfaces with adhesive and weld pins with exposed edges of insulation coated with adhesive.
 - 1. "K" value at 75 degrees F: Maximum 0.26 Btuh/inch/sq ft/degrees F.
 - 2. Density: 2 inch thick, 2.4 lbs./cu ft.
- F. Outside Finish: One coat metal primer with two finish coats of acrylic paint.
- G. Weatherproof Casing Finish: Seal fixed joints with flexible weather tight sealer. Seal removable joints with closed-cell foam gasket. Provide cap strips over roof flanges. Provide rain caps and gaskets on access doors.
- H. Access Doors:
 - 1. Provide an access door for each section subject to scheduled maintenance.
 - 2. 14 x14 inch, minimum, door of galvanized steel insulated sandwich construction, for flush mounting, with stainless steel hinges, gasket, quarter turn lockable latches. Sized appropriately to allow full service access to components housed within.
 - 3. The access doors shall be 1 ½ inches thick with closed cell foam with a minimum R value of 9.4.
- I. Factory Base Rail: Provide factory base rail of sufficient height to raise the unit condensate connections to provide height for the condensate trap as detailed on Drawings and routing of pipe to a roof drain as indicated.

- J. Unit shall be manufactured for mating with structural steel and shall be designed to be self-supporting other than full perimeter support and support at the shipping splits.
- K. Roof Mounting Curb:
 - 1. Roof curb mounting frame shall be approved by the National Roofing Contractors Association.
 - 2. Galvanized steel, 14 inches high, insulated with 1-1/2 inch thick rigid glass fiber and with wood nailing strip, and 1/2 x 2 inch curb-to-unit neoprene gasket.
 - 3. Provide roof curb isolation. Refer to section 230548.
- L. O.A. Intake Hood: Factory fabricated hood sized for the indicated airflow with factory finish matching unit. Provide hood with high performance moisture eliminator.
- M. Lights:
 - 1. Provide in accessible sections suitable for damp locations with wire guards, factory wired thru weatherproof switch duplex outlet to unit power cabinet mounted on casing exterior. In humidifier sections, provide lights suitable for wet locations.
- N. Instrument Test Ports: Provide air tight, resealable test ports in each section of the air unit for use in commissioning and testing. Mount at 5'-0" above unit floor. Test ports shall be minimum 1-inches diameter, galvanized steel or chrome plated with screw cap access. Install on exterior casing with matching pipe sleeve thru the casing wall. Provide gasketed collar ring at each wall penetration and fasten with stainless steel screws.
- O. Bottom Inlet Units: Provide steel or aluminum walking grate on structural supports.

2.4 FANS

- A. Type: Plug type fan(s), backward inclined or Airfoil as scheduled.
- B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.
- E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Provide access to motor, drive, and bearings through hinged access doors. Mount fan base on unhoused spring vibration isolators; refer to Section 23 0548.
- F. Flexible Connection: Provide factory flexible connection to isolate fan from casing and adjacent sections.

2.5 COILS

- A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B. Drain Pans: Drain pan(s) shall be insulated double wall welded stainless steel , pitched for flow to drain connection. Drain connection shall be dropped type to completely drain pan. Pan design shall pass the requirements of ASHRAE Std. 62R. Extend pan 24 inch, minimum, downstream of coil and provide down spouts for cooling coil banks more than one coil high.
- C. Coil Capacity: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
- D. Fabrication:
 - 1. Tubes: 5/8 inch OD 0.024 inch, or 3/8 inch OD 0.016 inch minimum, seamless copper expanded into fins, brazed joints.
 - 2. Fins: Aluminum, 144 fins per foot, maximum.
 - 3. Casing: Die formed channel frame of G90 galvanized steel
- E. Refrigerant Coils:
 - 1. Headers: Seamless copper tubes with silver brazed joints.
 - 2. Tubes: 5/8 inch OD 0.020 inch, minimum, seamless copper expanded into fins, brazed joints.
 - 3. Liquid Distributors: Brass or copper venturi distributor with seamless copper distributor tubes.
 - 4. Configuration: Down feed with bottom suction. Row depth shall be 1/2 rows deeper than calculated. Coil shall be two circuited , face split to match condensing unit.
 - 5. Face Velocity: Refrigerant coil face velocity shall not exceed 500 fpm
- F. Hot Gas Heating Coils:
 - 1. Headers: Seamless copper tubes with silver brazed joints.
 - 2. Tubes: 5/8 inch OD 0.020 inch, or 3/8 inch OD 0.016 inch minimum, seamless copper expanded into fins, brazed joints.
 - 3. Liquid Distributors: Brass or copper venturi distributor with seamless copper distributor tubes.
 - 4. Configuration: Down feed with bottom suction. Row depth shall be 1/2 rows deeper than calculated. Coil shall be single circuited, intertwined split to match condensing unit.
 - 5. Face Velocity: Refrigerant coil face velocity shall not exceed 500 fpm

2.6 ENTHALPY WHEEL (where scheduled)

- A. Enthalpy wheel shall recover both sensible and latent heat. The matrix shall be constructed from corrugated aluminum and specifically treated and coated with Silica Gel desiccant to assist and enhance latent heat transfer. No other desiccants will be accepted.
- B. Segmented wheel shall be provided on diameter sizes above 96".

- C. Seals shall be full contact, low bleed type, made from dual band Ultra High Molecular Weight Polyethylene. Any seal that is not in contact is not to be considered a seal and will not be acceptable.
- D. The drive system shall be operated by a fractional horsepower motor (maximum 1HP), reducing gear box, pulley and v-belt.
- E. Belts shall be made of multi-link urethane/polyester composite.
- F. The wheel bearing shall be permanently sealed and press fitted into the wheel matrix for long life operation.
- G. Wheel speed shall not rotate faster than 20rpm. Any rotational speed greater than 20rpm will be unacceptable.
- H. Media cleaning shall be accomplished with any of the following methods, without degrading the latent recovery:
 - 1. Compressed air
 - 2. Low pressure steam
 - 3. Hot water
 - 4. Light detergent

2.7 BURNER (INDIRECT GAS TYPE)

- A. Gas Burner: Forced draft type burner with adjustable combustion air supply, stainless steel heat exchanger tubes, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shut-off pilot.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after air flow proven and slight delay, allow gas valve to open.

2.8 FILTERS

- A. Section with filter guides, access doors from one side with latching handles, for side loading with gaskets, blank-off plates and casing access door.
- B. Filter Media: UL 900 listed, Class I or Class II, approved by local authorities.
- C. Flat: MERV 8, 2 inches deep disposable, extended area panel filters. Refer to section 23 4000.
- D. Filter Gauges:
 - 1. 2 inch diameter diaphragm actuated dial in metal case with static pressure tips.

2.9 COMPRESSORS

- A. Locate compressors, refrigerant accessories, unit controls, and power wiring in a separate section.

- B. Refrigerant: Precharge unit with R410A.
- C. Compressors: Hermetic reciprocating type or Hermetic scroll type.
- D. Mounting: Statically and dynamically balance rotating parts and mount on rubber-in-shear vibration isolators. Refer to Section 23 0548.
- E. Lubrication System: Reversible, positive displacement oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.
- F. Motor: Constant speed 3600 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Refer to Section 23 0513. Furnish with starter.
- G. Capacity Reduction Equipment: Suction valve unloaders, with lifting mechanism operated by electrically actuated solenoid valve, with unloaded compressor start; controlled from suction pressure.
- H. Sump Oil Heater: Evaporates refrigerant returning to sump during shut down. Energize heater thermostatically when compressor is not operating.

2.10 CONDENSER COILS

- A. Provide copper tube aluminum fin coil assembly with subcooling rows.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
- C. Provide refrigerant pressure switches to cycle condenser fans.
- D. Casing or protective guard shall protect condenser coil return bends and fins from damage.

2.11 REFRIGERANT CIRCUITS

- A. Provide each unit with minimum of two compressors or one compressor with multiple cylinders, factory supplied and piped.
- B. Provide for each refrigerant circuit:
 - 1. Filter dryer .
 - 2. Liquid line sight glass and moisture indicator.
 - 3. Thermal expansion valve sized for maximum operating pressure.
 - 4. Insulated suction line.
 - 5. Suction and liquid line service valves and gage ports.
 - 6. Liquid line solenoid valve.
 - 7. Charging valve.
 - 8. Discharge line check valve.
 - 9. Compressor discharge service valve.
 - 10. Condenser pressure relief valve.
 - 11. Suction line accumulator.

2.12 CONTROLS

- A. Provide unit specific color coded wiring diagrams shall match the unit color coded wiring and in both point-to-point and ladder form. Laminate diagrams in plastic and permanently affix inside the control compartment
- B. Provide safety controls arranged so any one will shut down machine and require manual reset:
 - 1. Smoke Detector: Unit shall be provided with a smoke detector(s) sensing in the supply air portion of the unit wired to shut off the unit control circuit.
 - 2. High discharge pressure switch for each compressor.
 - 3. Low suction pressure switch for each compressor.
 - 4. Oil pressure switch.
- C. Operating controls.
 - 1. Unit supply fan shall be configured for Constant Volume (ON/OFF).
 - 2. Operating protocol: The DDC shall be factory-programmed for BACNetIP.
 - 3. Digital controls with duct mounted sensors to control modulating hot gas reheat, when the compressors are operating, and to control the gas burner in sequence when ODT is below 60 degrees to maintain supply air temperature of 70 degrees F (adj) with maximum 55 degree leaving dewpoint (adj).
 - 4. Digital controls with sensor to control compressors to maintain a 54 degree discharge from the evaporator coil when ODT is 60 degrees and above, or as required to maintain maximum 55 degree dewpoint (adj).
 - 5. Provide terminal strip on unit for connection of unit status to BAS system by others.
 - 6. Motorized intake air dampers (N.C.) shall open when unit ON.
 - 7. Energy wheel speed shall modulate speed to optimize entering air conditions and initiate frost control.
- D. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.
- E. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.
- F. Variable Frequency Drive(s): unit shall have factory installed variable frequency drives for modulation of the supply and exhaust air blower assemblies to maintain setpoint supply (and exhaust where scheduled) airflow. The VFD(s) shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

2.13 POWER WIRING

- A. Provide unit specific color coded wiring diagrams shall match the unit color coded wiring and in both point-to-point and ladder form.
- B. Provide factory wired units with a single point of electrical connection and grounding lug.
- C. Provide across-the-line starter, non-recycling compressor overload, starter relay for each compressor. Provide manual reset current overload protection.
- D. Minimum short circuit rating: 42,000 amperes rms symmetrical.
- E. Provide starter relay for each condenser fan and motor with built-in overload protection.
- F. Power block terminals shall be provided for different wire size connections. Wiring shall be numbered and color coded for ease of trouble-shooting.
- G. Provide a surge capacitor and lightning arrestor in starter cabinet for protection from power surges due to lightning and switching transients.
- H. Ground shall be #6 A.W.G. Provide separate driven ground for ground mounted and connect to building steel for roof mounted units.
- I. Provide motor protector.
- J. Provide separate power connection for power for evaporator heat tape.
- K. Control Power Transformers: 120 volt secondary. 45 VA minimum. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.
- L. Exposed compressor and fan motor power wiring shall be routed in liquid tight conduit.
- M. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 2717

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.
- B. Verify that proper power supply is available.

3.2 INSTALLATION

- A. Rooftop equipment sizes are based solely on layout basis manufacturer/model as scheduled. Contractor to confirm layout of all selected rooftop equipment with dimensions and required clearances within platform/handguard dimensions prior to construction.

- B. Install in accordance with manufacturer's instructions.
- C. Drain Pan: Route discharge from cooling coil drain pan along roof to roof drain with drawn copper tube, full size of connection. Provide air seal trap(Refer to detail on drawings).
- D. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.3 STARTING EQUIPMENT

- A. Provide manufacturer's field representative to prepare and start equipment.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Demonstrate proper operation of equipment to Owner 's designated representative.
- D. Provide start-up certificate.

3.4 COMMISSIONING TESTS

- A. Provide assistance to the Commissioning Authority (CxA) for scheduling and witnessing of testing.
- B. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.

3.5 SCHEDULES: Refer to Schedule on Drawings.

END OF SECTION 23 7220

SECTION 23 8101 - TERMINAL HEAT TRANSFER UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electric heaters.

1.2 RELATED REQUIREMENTS

- A. Section 23 0510 - General Mechanical Requirements
- B. Section 23 0513 - MOTORS FOR HVAC EQUIPMENT.
- C. Section 23 0993 - Sequence of Operations for HVAC Controls.
- D. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections. Electrical supply to units.

1.3 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 3. Indicate mechanical and electrical service locations and requirements.
- D. Refer to Submittals in Section 23 0510 for requirements regarding Tabulation of Power Wiring Requirements.
- E. Manufacturer's Instructions: Indicate installation instructions and recommendations.
- F. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.4 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Refer to Section 23 0510 - General Mechanical Requirements for general delivery, storage and protection requirements.
- B. Do not operate duct mounted equipment until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.1 ELECTRIC WALL HEATERS (EWH)

- A. Manufacturer: Qmark Model AWH-4000.
- B. Other acceptable manufacturers offering equivalent products: Berko FRC, Electromode RFAC, Erincraft AWH, Markel 3400, Raywall AFA.
- C. Assembly: UL listed and labelled with terminal box and cover, and built-in controls.
- D. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- E. Enclosure: Minimum 0.030 inch steel box for surface mounting with finish with removable 16 gauge steel bar grille with satin finished aluminum frame.
- F. Fan: Direct drive propeller type, statically and dynamically balanced.
- G. Motor: Permanently lubricated, sleeve bearings.
- H. Built-in Controls:
 - 1. Power disconnect switch.
 - 2. Automatic reset thermal overload protector.
 - 3. Tamper-proof bi-metal thermostat with 40-90 Degree F range adjustable through grille face.
- I. Electrical Characteristics: Refer to Electrical drawings.

2.2 ELECTRIC UNIT HEATERS (EUH)

- A. Manufacturers:
 - 1. Berko; Model HUH.
 - 2. Electromode; Model EUH.
 - 3. INDEECO (Industrial Engineering and Equipment Company)
 - 4. Markel; Model 5100.
 - 5. Marley Engineered Products
 - 6. Raywall; Model UH.
- B. Assembly: UL listed and labelled assembly with terminal box and cover, and built-in controls.

- C. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- D. Cabinet: 0.0478 inch steel with easily removed front panel with integral air outlet and inlet grilles.
- E. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- F. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard.
- G. Motor: Permanently lubricated, sleeve bearings for horizontal models, ball bearings for vertical models.
- H. Control: Separate fan speed switch and thermostat heat selector switch, factory wired, with switches built-in behind cover. Provide thermal overload.
- I. Electrical Characteristics:
 - 1. Refer to the power requirements indicated on the electrical drawings.

2.3 ELECTRIC CABINET HEATERS (ECH)

- A. Manufacturers: Berko CUH, Electromode 'AA', Erincraft ECH, Markel 6300, QMark CU, Raywall 'T'.
- B. Layout Basis: Qmark CU.
- C. Assembly: UL listed and labelled assembly with terminal box and cover, and controls.
- D. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material.
- E. Cabinet: 0.0598 inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet and inlet grilles.
- F. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.
- G. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- H. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard.
- I. Motor: Tap wound multiple speed permanent split capacitor with permanently lubricated, sleeve bearings, resiliently mounted.
- J. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before heating elements.
- K. Configuration:
 - 1. VWMRU: Vertical, wall mounted, recessed unit with extruded horizontal supply and return grilles, with recess trim kit.

- L. Built-in Controls:
 - 1. Power disconnect switch.
 - 2. Automatic reset thermal overload protector.
 - 3. Tamper-proof bi-metal thermostat with 40-90 Degree F range adjustable through grille face.
 - 4. Fan Control: Multiple speed switch, factory wired, located in cabinet with integral fan delay switch.
 - 5. Two-stage heating controls.
- M. Electrical Characteristics:
 - 1. Refer to the power requirements indicated on the electrical drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install terminal units in a readily accessible location.
- C. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.
- D. Protection: Provide finished cabinet units with protective covers during balance of construction.
- E. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- F. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.
- G. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal.
- H. Install electric heating equipment in accordance with Section 26 2717 .

3.2 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets to "like new" appearance, using finish materials furnished by manufacturer.
- C. Install new filters.

3.3 SCHEDULES

- A. Refer to Schedules on the Drawings.

END OF SECTION 23 8101

SECTION 23 8130 - DUCTLESS SPLIT SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior Unit.
- B. Exterior Unit.
- C. Controls.

1.2 RELATED SECTIONS

- A. Section 23 0510 - General Mechanical Requirements - Warranty.
- B. Section 23 0513 - Motors for HVAC Equipment: Evaporator and condenser fan motors.
- C. Section 23 2300 - Refrigerant Piping and Specialties.
- D. Section 23 0913 - Instruments and Control Elements: Installation and wiring of thermostats and other control components.
- E. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning and Refrigeration Institute 2008.
- B. ARI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning and Refrigeration Institute; 1995.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 1993 (and Revision 1,2,3,4).

1.4 PERFORMANCE REQUIREMENTS

- A. Air entering exterior coil-summer: 95 degrees F.
- B. Coordinate refrigerant pipe routing with Contractor and provide equipment whose scheduled length limitation exceeds the refrigerant piping length requirements.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.

- B. Product Data: Provide data for manufactured products and assemblies. Indicate water, drain, thermostatic valves, and electrical rough-in connections with electrical characteristics and connection requirements.
- C. Refrigerant Piping: Obtain manufacturer's recommendations for piping and piping appurtenances for the equipment supplied and incorporated into the refrigerant piping specified in Section 23 2300.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. See Section 23 0510 - General Mechanical Requirements, for additional Warranty requirements.
- C. Provide a five year warranty to include coverage for compressor including materials only.

1.8 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Provide one set of filters for each unit at Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Daikin AC.
- B. Liebert.
- C. LG Electronics.
- D. Mitsubishi .
- E. Samsung.

2.2 AIR CONDITIONING UNITS

- A. Description: Packaged, ductless split air conditioning systems as scheduled consisting of interior and exterior units and controls.

2.3 INTERIOR UNIT

A. Cabinet

1. Decorative cabinet with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet and inlet grilles.
2. Finish: Factory apply baked enamel of color as selected on visible surfaces of enclosure or cabinet.
3. Insulation: Minimum 1/2 inch thick acoustic duct liner for lining cabinet interior.
4. Drain Pan: Galvanized steel with corrosion-resistant coating. Provide integral condensate pump for remote transfer of the drain pan condensate.

B. Evaporator fan

1. Fan: Direct drive, double width, double inlet, forward curved centrifugal fan, statically and dynamically balanced, resiliently mounted.

C. Evaporator coil

1. Direct expansion coiling coil of seamless copper tubes expanded into aluminum fins.
2. Refrigeration circuit with fixed metering device (capillary tube) unless noted otherwise.

D. Air filters

1. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.

2.4 EXTERIOR UNIT

A. Casing

1. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
2. Mount contactors and controls in weatherproof panel provided with full opening access doors.
3. Provide removable access doors or panels with quick fasteners .

B. Compressor

1. Hermetically sealed, 3600 rpm maximum, resiliently mounted with positive lubrication and internal motor protection.
2. Compressor: Hermetic scroll type.

C. Condenser coils

1. Coils: Aluminum fins mechanically bonded to seamless copper tubing or all aluminum fins and tube. Air test under water to 600 psig, and vacuum dehydrate. Seal with holding charge of refrigerant.
2. Coil Guard: Louvered or PVC coat steel wire .

- D. Fans and motors
 - 1. Direct driven propeller type condenser fans with fan guard on discharge.
 - 2. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor with permanent lubricated ball bearings and built in thermal overload protection.
 - 3. Fan Guard: PVC coat steel wire.
- E. Refrigerant: Charge with R-410A.
- F. Refrigerant circuit
 - 1. For each refrigerant circuit, provide:
 - a. Suction and liquid line service valves and gage ports.
 - b. Charging valve.
 - c. Condenser pressure relief mechanism.
- G. Controls
 - 1. Factory wired with single point power connection.
 - 2. Factory wired controls shall include contactor, high and low pressure cutouts, internal winding thermostat for compressor, control circuit transformer, non-cycling reset relay.
 - 3. Provide a surge capacitor and lightning arrestor in unit cabinet for protection from power surges due to lightning and switching transients.
 - 4. Provide controls to permit operation down to 0 degrees F ambient temperature to include:
 - a. Crankcase heater with thermostat.
 - b. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
 - c. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.

2.5 CONTROLS

- A. Provide electric solid state microcomputer based room thermostat, located as indicated.
 - 1. Incorporate:
 - a. Preferential rate control to minimize overshoot and deviation from set point.
 - b. Set-up for four separate temperatures per day.
 - c. Instant override of setpoint for continuous or timed period from one hour to 31 days.
 - d. Short cycle protection.
 - e. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
 - 2. Display shall include:
 - a. Time of Day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System mode indication.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide level housekeeping pad or base as indicated.
- C. Pipe refrigerant piping from interior unit to exterior unit; refer to section 23 2300.
- D. Drain Pan: Route discharge from cooling coil drain pan to floor drain or to remote drain location as shown with drawn copper tube, full size of connection. Provide air seal trap (Refer to detail on drawings).

3.2 SCHEDULES

- A. Capacities shall not be less than scheduled when matched together; 45 F minimum SST, 95 F ODT.
- B. Refer to schedule on Drawings.

END OF SECTION 23 8130

SECTION 23 8132 - WATER SOURCE HEAT PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Heat Pump Units.
- B. Controls.

1.2 RELATED SECTIONS

- A. Section 23 0510 - General Mechanical Requirements - Warranty.
- B. Section 23 0513 - Motors for HVAC Equipment: Evaporator fan motors.
- C. Section 23 0913 - Instruments and Control Elements: Installation and wiring of thermostats and other control components.
- D. Section 23 0994 - HVAC Sequence of Operation
- E. Section 23 2113 - Hydronic Piping: Condenser water piping and valves.
- F. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ARI/ISO Standard 13256-1.
- B. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2010 (ANSI/ASHRAE/IESNA Std 90.1).
- C. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2004.
- D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 1993 (and Revision 1,2,3,4).
- E. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems; National Fire Protection Association; 2012.

1.4 SUBMITTALS

- A. Product Data: Provide data for manufactured products and assemblies. Indicate water, drain, and electrical rough-in connections with electrical characteristics and connection requirements.

- B. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- C. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Verify upon delivery that equipment nameplate data, including electrical data, matches specified and ordered equipment. Verify that refrigerant charge has been retained during shipping.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store products under cover and elevated above grade.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's standard warranty for a one year period after Date of Substantial Completion.
- C. ALTERNATE: Provide five-year manufacturer's warranty after Date of Substantial Completion to include coverage for all unit components - materials & labor.

1.8 EXTRA MATERIALS

- A. Provide one new set and one spare set of disposable panel filters at Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Layout Basis: Trane Company; Model EXH
- B. Acceptable Manufacturers:
 - 1. Aeon WH
 - 2. Johnson Controls RBSH

2.2 HEAT PUMP UNITS

- A. Heat Pumps: Factory-assembled water-source heat pump; unit comprised of but not limited to the following components: compressor, reversing valve, refrigerant thermal expansion valve, refrigerant-to-water condensing coil, evaporator coil, filters, motors, hoses, controls, and internal wiring.
- B. Units shall have Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1 - 2010.
- C. Assembly: Horizontal flow, as scheduled, in draw-through configuration as indicated. Arrangement of supply air and return air connections shall be as indicated on the plans.
- D. Acoustic Package: Provide deluxe acoustic attenuation package to include heavy gauge lined cabinet construction, compressor/heat exchanger vibration isolation, and panel gasket sealant.
- E. Electrical Characteristics:
 - 1. Complete internal factory wiring including a 24-volt control transformer, compressor contactor, blower relay, high pressure and low temperature safety cutouts with a common reset relay and field wiring strip.
 - 2. Single point power service connection.
- F. Cabinet
 - 1. Frame and Panels: Heavy gauge galvanized steel with baked enamel finish, easily removed access doors or panels with quick fasteners to allow access to all internal components. Access doors or panels shall be fastened to unit with slots or hinges and self-tapping screws.
 - 2. Insulation: Minimum 1/2 inch thick acoustic duct liner for lining cabinet interior.
 - 3. Provide four hanger bracket assemblies and rubber-in shear isolators for horizontal mounted units.
 - 4. Pipe Connections: Copper FPT connections brazed to copper water tubes. Condensate drain connection shall be minimum 3/4-in. FTP fitting.
 - 5. Low Temperature Pipe, Tubing, and Heat Exchangers: Insulated with elastomeric insulation having flame spread index less than 25 and smoke developed index of less than 50, when tested in accordance with ASTM E84; and UL 94 rated.
 - 6. Drain Pan: Corrosion resistant materials, double-sloped and insulated.
- G. Evaporator fan
 - 1. Fan: Direct drive, forward curved centrifugal fan, statically and dynamically balanced, resiliently mounted with permanently lubricated bearings, ECM variable speed motor with internal overload protection and easily removable for service.
 - 2. Fan/motor assembly shall be easily removed for service.
- H. Evaporator coil
 - 1. Direct expansion coiling coil of seamless copper tubes expanded into corrugated aluminum fins, maximum 14 fins per inch and constructed for 450 PSIG working pressure.
 - 2. Refrigeration circuit with externally equalized thermal expansion valve.

- I. Refrigerant-to-Water Heat Exchangers: Coaxial (tube-within-a-tube) type, tested and rated for 600 psi refrigerant working pressure and water side working pressure of 400 psi. Inner copper water tube and outer steel refrigerant tube. Provide vibration isolation of heat exchanger assembly.
- J. Air Filters
 - 1. Easily removed 1 inch thick disposable glass fiber panel filters.
- K. Compressor
 - 1. Hermetically sealed, resiliently mounted, with internal and external isolation, and thermal overload protection.
 - 2. Compressor: Hermetic scroll type.
- L. Refrigerant circuit
 - 1. Completely piped, tested, dehydrated, and charged with oil prior to being shipped from the factory. Sealed R-410 refrigerant circuit.
 - 2. Provide the following refrigerant circuit components from the factory:
 - a. Thermal expansion valve
 - b. 4-way reversing valve
 - c. Suction and liquid line service ports.
 - d. High pressure and low pressure safety switches
 - e. Low-suction temperature sensor
 - f. Condenser pressure relief mechanism
- M. Piping Specialties:
 - 1. Flexible Pipe Connections: Braided stainless steel hoses with EPDM inner core; swivel connectors; UL 94 rated.
 - a. Minimum Working Pressure: 300 psi.
 - b. Length: 3 feet, minimum.
 - 2. Provide the following.
 - a. Automatic flow control valve with test ports.
 - b. Two shut-off ball valves.
 - c. Y-strainer.
 - d. Automatic two-position isolation valve.
 - e. Test Ports.
 - f. Unions.
 - 3. These components may be field installed separately, or a pre-piped valving package providing the same devices may be installed at the Contractor's option. Refer to heat pump piping diagram.
- N. Operating Controls
 - 1. Complete, factory installed, UL listed controls including a 24-volt transformer.
 - 2. Control panel shall be provided by controls vendor for factory installation; Refer to 230923.
 - 3. Factory provided condensate overflow switch to be field installed. Provide relay to shut off unit via condensate overflow switch and send alarm to the BAS.
 - 4. Anti-short cycle timer, adjustable from 1 to 300 seconds set from the factory to 300 seconds, for compressor only. Fan shall operate while compressor is being locked out by short cycle timer.

5. Provide low voltage, adjustable room thermostat to control compressor, condenser, and supply fan to maintain temperature setting. Refer to 23 0913.
6. Compressor shall cycle upon call for heating and cooling.
7. Refer to Section 23 0994 - HVAC Sequence of Operation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that power supply complies with equipment specifications.
- B. Verify that all connections for water and electricity are available, operational, and placed correctly for unit installation.
- C. Verify that equipment is undamaged, including refrigerant components and valves and electrical connections.
- D. Verify that substrates are sound and ready for installation.
- E. Do not begin installation until installation sites have been properly prepared. If installation site preparation, such as the water source, is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Do not obstruct maintenance access to equipment by any type of piping, electrical conduit, or any other utility.
- C. Drain Pan: Route discharge drain piping from cooling coil drain pan as shown on plans with drawn copper tube, full size of connection. Provide air seal trap.
- D. Provide 22 gauge, G90 galvanized steel, auxiliary drain pan, 1 1/2 inches deep and extending beyond unit 3 inches on all sides, on units in locations other than in mechanical equipment rooms with floor drains. Mount factory condensate overflow switch in auxiliary drain pan and wire to unit.
- E. Install and mount factory provided thermostat and wire to units per manufacturer's recommendations. Refer to section 23 0913 for mounting of thermostats.

- F. Install flexible connections between fan outlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and unit while running.
- G. Connections to condenser water piping:
 - 1. On the supply side of the unit , provide an isolation valve, strainer, and flexible connector.
 - 2. On the return side of the unit, provide a flexible connector, automatic flow control valve, two-position control valve, and isolation ball valve.
 - 3. Refer to Section 23 2113 for piping and valves.
 - 4. These components may be field installed separately, or a pre-piped valving package providing the same devices may be installed at the Contractor's option.

3.4 STARTING EQUIPMENT

- A. Prior to starting any heat pump unit, all central condenser water loop controls, equipment, and instrumentation shall be installed and operating in specified manner.
- B. Flush and clean piping before placing in operation; take precautions to prevent introduction of debris into piping systems.
- C. Provide a temporary bypass between the supply and return outlets at each unit and flush all system piping as specified in Section 23 2500 prior to connecting any heat pump unit to the water piping.

3.5 SCHEDULES

- A. Refer to schedule on Drawings.

END OF SECTION 23 8132

SECTION 26 0510 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Definitions
- B. Quality Assurance Requirements and Installer Qualifications.
- C. Submittal Procedures
- D. Execution Requirements common to Division 26 systems
- E. Equipment bases and housekeeping pads

1.2 DEFINITIONS

- A. Manufacturer's Representatives: Wherever MANUFACTURER'S REPRESENTATIVE is referred to in this division, said representative shall be regularly employed by the manufacturer to perform similar activities to those called for herein, which indicates his competence in that field of work.
- B. Concealed: Where the word concealed is used in this Division, it shall mean items above ceilings, in attics, in crawl spaces, in chases, in tunnels, in cabinet work, and under counters or equipment so as to be not visible from an elevation of 5 feet at a horizontal distance of 10 feet.
- C. Finished Spaces or Areas: Where finished spaces or areas are referred to in this Division, it shall mean all spaces except concealed spaces, mechanical rooms, or boiler rooms unless otherwise noted.
- D. Provide: Where the word provide is used, it shall mean to furnish and install the item(s) in accordance with plans, specifications or manufacturer's instructions.
- E. Control and Interlock Wiring: All wiring, both line voltage and low voltage, other than power wiring from an electrical distribution panel, through the primary control device, to the equipment.
- F. Primary Control Device: That ONE device for any item of equipment which interrupts power flow during normal operation. Where magnetic starters are provided, they are the primary control. For items not switched by starters, the primary control device will be the ONE thermostat, manual switch, aquastat, P.E. switch, or relay performing the primary switching.
- G. Diagrammatic: A drawing that shows arrangement and relations (as of parts).i.e.: A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts, conduit and other items shown and is not necessarily to scale. Arrangement, location, and sizes shown are firm.

- H. **Readily Accessible:** Equipment, valves and other items requiring service shall be installed to be readily accessible. These items shall be available for maintenance or use in a space, through an access door from floor elevation, or above a lay-in ceiling by maintenance staff standing on a ladder no taller than the ceiling.
- I. **Noted, Indicated or Shown:** Where the terms "Noted", "Indicated" or "Shown" are used in these specifications, the words "in the specifications or on the plans" shall be inferred.
- J. **Detail:** Details referenced shall pertain to plans unless otherwise noted.
- K. **Specifications:** Where reference is made to these specifications, it shall be inferred in this Division of specifications.
- L. **Notification by Contractor, and Instructions to Contractor:** Where reference is made in these specifications to notification by or instructions given to Contractor, it shall be inferred that Architect shall be the notifier or the instructor as the case exists.
- M. **Submittal Data, Equipment Cuts, Shop Drawings:** Wherever these terms are used in the plans or specifications, the information is to be submitted for review as part of the packaged submittal specified under "SUBMITTALS".
- N. **Conduit of Duct Bank:** Two or more, 2-inch or larger conduits with a common point of origin and a common point of termination routed parallel, and as specifically designated on plans.
- O. **See Article 100 of the 2017 National Electrical Code with all Georgia State Amendments.**
- P. **Division or Section Reference:** Where reference is made to another Division or Section within this Division, refer to specifications table of contents for Division, Section, or Page Number.
- Q. **Diagrammatic:** A drawing that shows arrangement and relations (as of parts). A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts, conduit and other items shown and are not necessarily to scale. Arrangement, location and sizes shown are firm.
- R. **Horizontal Cabling:** A data cabling term indicating the cable from the work area back to the patch panel. Commonly used in the description "conduit for horizontal cabling shall be 1" minimum in size".

1.3 REGULATORY REQUIREMENTS

- A. **General:** Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications.
- B. **Materials and equipment included in Underwriters Label Service shall bear that label.** Electrical equipment shall be U.L. approved as installed.
- C. **Jurisdiction:** Where codes or guides refer jurisdiction to local governing code officials, such official in this procedure shall be the State Fire Marshal.

- D. Permits: Permits and licenses of a temporary nature necessary for the prosecution of the work shall be obtained and paid for by Contractor. Neither Contractor nor any sub-contractor will be required to pay Municipal or County building permit fees. The Contractor and/or any subcontractor will be required to pay any Municipal and/or County building license taxes or fees, if any.
- E. Energy: Conform to the International Energy Conservation Code, 2015 Edition, with all Georgia State Amendments.
- F. All Work: Conform to State of Georgia Chapter 120-3-3 "Rules of Safety Fire Commissioner, Rules and Regulations, January 1, 2018", and ADA.
- G. Fire Prevention: Conform to Georgia State Minimum Standard Fire Prevention Code (International Fire Code), 2018 Edition, with all Georgia State Amendments.
- H. Building Code: Conform to the Georgia State Minimum Standard Building Code (International Building Code), 2018 Edition with all Amendments.
- I. Electrical: Conform to the 2017 National Electrical Code (NEC), NFPA, and the National Electrical Safety Code.
- J. Life Safety: Conform to the 2018 Edition of NFPA 101 - Life Safety Code, with Georgia State Amendments.
- K. Fire Alarm: Conform to the 2019 Edition of NFPA 72 - National Fire Alarm Code, with Georgia State Amendments.

1.4 PERFORMANCE REQUIREMENTS

- A. Requirements specified herein are minimum. All equipment, when installed, shall perform equal to or exceed specified requirements.

1.5 SUBMITTALS

- A. Refer to Section 01 7800 - Closeout submittals, for general submittal procedures.
- B. In general, the design professional is allocated 14 calendar days to review a submittal. On large items such as gear, panel, and lighting submittals, our office will require this same amount of time, and should receive copies of these submittals at the same time as the design professional. Special circumstances may require faster turnaround times, and may be discussed at the onset of the submittal process.
- C. Supplementing Division 1 requirements; Contractor shall:
 - 1. Review the submittal data and check to ensure compliance with specifications prior to submitting.
 - a. The Contractor agrees that submittals of equipment and material and shop drawings of equipment and material layouts required under provisions of these specifications and processed by the Architect are not Change Orders.
 - b. The purpose of submittals is to demonstrate that Contractor understands the design concept of the project by indicating the equipment and materials he

- intends to furnish and install, and by detailing the installation he intends to achieve. The review by Architect shall NOT be construed to be for the purpose of "approving" equipment or drawings. The plans and specifications alone are the contract document. The contractor has agreed to follow the contract document, regardless of the results of the submittal submission.
- c. The Contractor shall conform to the requirements of the Contract Documents unless a change order or a specific letter of clarification is issued. The Contractor shall identify on each submittal and in letter form to Architect any and all deviations from the Contract Documents.
 - d. Any submittal or shop drawing not conforming to the Contract Documents without this identification and notification shall be assumed to be marked "Revise and Resubmit" (Contractor acknowledges this by the submission), and Contractor shall promptly resubmit said submittal so as to be in full compliance with the Contract Documents.
 - e. Failure of Contractor to provide this information during the shop drawing phase shall make Contractor responsible for all changes to achieve compliance with the Contract Documents without additional compensation.
2. Assemble the submittal data in compete sets in hard back three-ring binders, separated by trade, (Electrical and Telecommunications), and bound with numbered index sheets and tabs. Submittal data shall be submitted at one time unless unavailable data such as control submittal would delay project progress. Submittal data for Fire Alarm System and Electric Generator System shall include the following:
 - a. Devices and panels data sheets.
 - b. Typical devices wiring diagrams.
 - c. Plans showing devices, zone of each device, & interconnecting conductor/conduit.
 - d. System operation description.
 3. Identify all submittals by a cover sheet showing project name, specification sections, drawing or detail number, room number, date, revision date, Contractor and subcontractor's organization and project manager with phone number, the model, style and size of item being submitted with manufacturers' representative, salesman (or a preparer who can answer questions), and preparer's phone number.
 4. Manufacturers' standard drawings shall be modified by deletions or additions to show only items applicable to this project.
 5. Prepare a master list of submittals proposed to be submitted on the project. This list shall be updated for each submission and shall be the first sheet(s) of the submission in the quantity that is submitted for review. The information and general format shall contain an Tab number, Item Description, Item Status and any comment. Items that require quicker submittal review because of material lead times should be indicated in this list.
 6. Provide a Letter stating that all submittals have been checked for compliance with specifications.
 7. Deliver submittals to the Architect at the business address.
 8. Paperless Delivery of Submittal:
 - a. Submittal data may be posted to NBP's FTP site when agreed upon by the Design Professional and the Owner during preconstruction. The Contractor will be provided with a project folder and password.
 - b. Prepare the submittals as described above. Take steps to reduce submittal file size.

- c. Do not scan in color or high resolution unless needed for clarity.
 - d. Ensure any reproduction are legible.
 - e. Send an email to submittal@nbpengineers.com with a copy to the Electrical Design Professional and the Architectural Design Professional identified during the preconstruction phase.
 - f. Identify the submittal in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administration Building Section 26 0534- Conduit.
 - g. Ensure the submittal posted to the FTP site has the same identification.
 - h. NBP Design Professionals will not process or react to submittals not properly sent or identified.
- D. Power Wiring Requirements: The Contractor shall submit a letter acknowledging receipt and review of the Tabulated List of Power Wiring Requirements of all Mechanical Equipment specified in Division 23 of the Specifications. Failure to submit this letter will require Contractor to assume responsibility for any required changes to the electrical design attributed to mechanical equipment. Include a copy of the Tabulated List of Power Wiring Requirements with the letter. The electrical requirements for the mechanical equipment is based on the best information available at the time of design. The Contractor is responsible for coordinating with the purchased equipment. Power Wiring letters are required for the following equipment:
- 1. Mechanical
 - 2. Lab equipment
- E. Certificates:
- 1. For Fire Alarm System and Electric Generator System: Start-up, testing and placing into operation shall be performed by the field representatives of the manufacturers.
 - 2. Certificates of the manufacturers shall be provided on the letter heads of the manufacturers in which the manufacturer certifies that the equipment has been installed in strict compliance with the manufacturers recommendations and is operating properly.
 - 3. The manufacturers shall list in the certificate the item or items furnished to the job.
 - 4. The Contractor shall coordinate performance of the aforesaid services and shall, in all cases where the equipment of two or more manufacturers tie in and function together, require the field representatives to perform simultaneously the initial start-up, the testing, and the placing of their equipment into operation. Start-up is defined as putting the equipment into action. Testing is defined as performing such testing as is stipulated in the contract documents to be performed. Placing into operation is defined as operating the equipment for a sufficient period of time for the determination to be made that it is performing properly.
 - 5. Notification shall be given at least 48 hours in advance of start-up. The Contractor shall give each system supplier the advance notice time he requests for his work on his system.

1.6 OPERATING AND MAINTENANCE MANUALS

- A. Each Manual shall be compiled as follows:
- 1. Data shall be bound in smooth surface hard back commercial quality three-ring notebooks with project identification shown on the front cover and binding back. Identification labels shall be typed and adhered with waterproof glue.

2. Notebooks shall have 9-1/2-inch by 11-1/2-inch covers with back width to permit the covers to lie parallel or to converge, and have not less than 1-1/2-inch back width.
 3. Index divider sheets of heavy Manila paper shall be inserted between each section of the Manual with a 2-inch x 1/3-inch ready-cut shield tab attached to each sheet for identification of sections.
 4. Data sheets and diagrams shall be 8-1/2-inch x 11-inch or be mounted on 8-1/2-inch x 11-inch sheets of 16-pound paper if smaller, with reinforced 11-inch mechanically perforated edges. Drawings and diagrams larger than 8-1/2-inch by 11-inch shall be folded up from the bottom to form a height of 11-inches and folded to the left to form a width of 8-1/2-inches.
 5. Table of Contents(Index) sheets shall be provided in the order listed with identifications typed in capital letters.
- B. Digital delivery of Operating and Maintenance Manuals:
1. Operating and Maintenance Manuals may be delivered digitally and posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and password.
 2. Prepare the Operating and Maintenance Manuals as described above. Take steps to reduce submittal file size.
 3. Do not scan in color or high resolution unless required for clarity.
 4. Ensure any reproductions are legible.
 5. Send an email to submittal@nbpengineers.com with a copy to the Electrical Design Professional and the Architectural Design Professional identified during the preconstruction phase.
 6. Identify the manuals in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building.
 7. Table of Contents(Index) sheets shall be included in the order listed with identifications typed in capital letters.
 8. Ensure the manuals posted to the FTP site has the same identification.
 9. NBP Design Professionals will not process or react to manuals which are not properly transmitted, indexed, and identified.
- C. Each Manual shall contain the following information, data and drawings:
1. Copies of approved submittals (with Design Professional's review comments and stamp), equipment and materials.
 2. Manufacturer's installation, operating and maintenance instructions for each item of equipment.
 3. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
 4. Control diagrams.
 5. Wiring diagrams and color codes for fire alarm system. Refer to fire alarm specifications.
 6. Copies of shop drawings showing layouts and construction details. Shop drawings are required for the following systems:
 - a. Lighting control (occupancy sensor, dimming and relay panels)
 - b. Fire Alarm system
 - c. Low voltage system (voice/data/catv)
 7. Testing Results: Coordination Study, final settings on all adjustable breakers.

8. Provide a copy of the riser diagram, no smaller than printed on 11X17, with lengths of feeders shown (handwritten is acceptable).
9. Maintenance schedules.
10. Warranty Information.
11. Sign in sheets for all owner training sessions.

1.7 QUALITY ASSURANCE

A. Electrical Installer's Qualifications:

1. General: Wherever the word "Sub-Contractor" or "Firm" is used in these subparagraphs, it shall mean Contractor/sub-contractor of record for the installations used for proficiency qualification.
2. Warranty of Contractor: The Contractor shall warrant that the Firm(s) selected by him are reputable, skilled, reliable, competent, qualified in the trade or field in which they are to perform on the project, and thoroughly familiar with applicable codes and standards.
3. Location: The firm which performs the installation of the work under this section shall be one who maintains an established, experienced organization with a permanent, manned office. See General Conditions.
4. Experience: The firm's proficiency in the installation and adjustment of Electrical systems shall have been demonstrated by the successful performance of work as specified herein on at least three commercial, hospital or institutional buildings with a minimum floor area of 25,000 square feet, 480 volt, 1200 amps, 3 phase service entrance.
5. The firm shall have been in business performing services as specified herein for at least 3 years.

B. Activity Log Book:

1. A Log Notebook of tear-out sheet type, with consecutively numbered pages shall be maintained on site by the Project Superintendent providing a continuous record of tests, equipment start-up, system start-up/check out for the length of the project.
2. Notebook entries shall include data; description of test/check out; sub-contractor involved; personnel involved; and results.
3. The Contractor shall turn over original notebook and two (2) first generation copies to Architect at final inspection.

C. Substitutions:

1. All costs incurred by acceptance of substitutions shall be borne by Contractor. Should any proposed substitute equipment require services in addition to or in excess of services provided in the Contract Documents, these services shall be provided at no extra cost to Owner.
2. Request for approval of a proposed product (substitution) shall be accompanied by the schedule setting forth in which respects the materials or equipment submitted for consideration differ from the materials or equipment designated in the Contract Documents and from the design intent. If there are no deviations or changes required to the design, the submittal shall be accompanied by the following statement: "The proposed material or equipment submitted for approval requires no changes to the Contract Documents to achieve the design intent." Lack of the schedule or statement will result in automatic disapproval of the request.

3. Facsimile (Fax) Requests for prior approval will not be considered due to the inability of the sender being able to assure that information sent was information received and possible poor clarity of the fax, and the short time period for review and response.

D. Architectural And/Or Structural Requirements:

1. Refer to the specifications and Architectural and Structural drawings for additional requirements pertaining to work under this discipline. Notify Architect if conflict for clarification.

1.8 WARRANTY

- A. Refer to Section 01 7000 - Project Closeout for additional warranty requirements.
- B. Where extended warranties beyond Contractor's one (1) year warranty are specified, the additional warranty time shall start at the end of Contractor's warranty.
- C. Correct defective Work within a one year period after Date of Material Completion.

1.9 NOTIFICATION TO THE OWNER WHEN THE CONTRACTOR VISITS SITE AFTER FINAL INSPECTION

- A. When Contractor's representative visits the job after the final inspection to perform specific work such as maintenance service, seasonal balance, or to correct a deficiency, Contractor shall notify Owner not less than 48 hours prior to the date on which they will visit the site, except under an emergency condition.
- B. The Contractor shall visit the designated office of Owner to notify Owner that Contractor is on the site prior to visiting the site, thereby enabling Owner's representative to accompany Contractor, should they so desire while Contractor is on the project site.
- C. A carbon copy of the notification shall be provided to Architect with the intent of the site visit. After Contractor has completed the site visit, Contractor shall give a written report of the action taken and any incomplete work yet to be performed to Architect, within five (5) days.

1.10 ABBREVIATIONS - ELECTRICAL

AIC	AVAILABLE INTERRUPTING CAPACITY
A.F.F.	ABOVE FINISHED FLOOR
AL	ALUMINUM
ANT	ANTENNA
AWG	AMERICAN WIRE GAUGE
B.E.	BOTTOM ELEVATION

B.G.	BELOW FINISHED GRADE
BRKR	BREAKER
C	CONDUIT
CAT.	CATALOG
CLG	CEILING
C.O.	CONVENIENCE OUTLET
COND.	CONDUCTOR(S)
CU	COPPER
D.	DIAMETER
EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
F.O.	FIBER OPTIC
FAP	FIRE ALARM PANEL
FUT	FUTURE
GND	GROUND
H-O-A	HAND-OFF-AUTO
HTR	HEATER
I.A.W.	IN ACCORDANCE WITH
IMC	INTERMEDIATE METALLIC CONDUIT
MB	MAIN BREAKER
MFGR	MANUFACTURER
MLO	MAIN LUGS ONLY
MTD	MOUNTED
MTG	MOUNTING
N.E.C.	NATIONAL ELECTRICAL CODE (2017)
NFDS	NON FUSED DISCONNECT SWITCH
N.I.C.	NOT IN CONTRACT

NMC	NON METALLIC CONDUIT
NO.	NUMBER
PLCS	PLACES
PVC	POLYVINYL CHLORIDE
R.	RADIUS
R.G.S.	RIGID STEEL CONDUIT
SCHED.	SCHEDULE
SEC.	SECTION
SMR	SURFACE METAL RACEWAY
SURF.	SURFACE
SYM	SYMMETRICAL
TEL.	TELEPHONE
TYP.	TYPICAL
W/	WITH
WP	WEATHERPROOF
XFMR	TRANSFORMER
20A/3P	20 AMP / 3 POLE TYPICAL

PART 2 PRODUCTS

2.1 TRADE NAMES

- A. When reference is made in the contract documents to trade names, brand names, or to the names of manufacturers, such references are made solely to indicate that products of that description may be furnished and are not intended to restrict competitive bidding. If it is desired to use products of trade or brand names or of manufacturer's names which are different from those mentioned in the contract documents, application for the approval of the use of such products must reach the hands of the Architect at least ten days prior to the date set for the opening of the bids. The latter provision is a restriction which applies only to the party making a submittal. Therefore, the aforesaid restriction does not inhibit the Contractor from adding trade names, brand names, or names of manufacturers by addendum.
- B. The burden of proving acceptability of a proposed product for use in place of a product or products designated by trade names or names, brand name or names, or by the name or names of manufacturers in the contract documents rests on the party submitting the

request for approval. The written application for approval of a proposed product must be accompanied by technical data which the party requesting approval desires to submit in support of its application.

- C. The Architect will give consideration to reports from reputable independent testing laboratories' verified experienced records showing the reputation of the proposed product with previous users, evidence of reputation of the manufacturer for prompt delivery, evidence of reputation of the manufacturer for efficiency in servicing its products, or any other written information that is helpful in the circumstances. The application to Architect for approval of a proposed product must be accompanied by a schedule setting forth in which respects the materials or equipment submitted for consideration differ from the materials or equipment designated in the contract documents. The degree of proof required for approval of a proposed product as acceptable for use in place of a named product or named products is that amount of proof necessary to convince a reasonable person beyond all doubt.
- D. To be approved, a proposed product must also meet or exceed all express requirements of the contract documents. If the submittal is approved by Architect, an addendum will be issued to all prospective bidders. Issuance of an addendum is a representation to all bidders that Architect in the exercise of his professional discretion established that the product submitted for approval is acceptable and meets or exceeds all express requirements. In the event a submittal shall have been rejected by Architect and there shall have been a request for a conference as provided in the article pursuant to which conference the said submittal shall have been found to comply with the requirements of this article, a separate addendum covering the said submittal will be issued prior to the opening of the bids.
- E. In order for Architect to prepare an addendum intelligently, an application for approval of a product must be accompanied by a copy of the published recommendations of the manufacturer for the installation of the product together with a complete schedule of changes in the drawing and specifications, if any, which must be made in other work in order to permit the use and installation of the proposed product in accordance with the recommendations of the manufacturer of the product. Unless request for approval of other products have been received and approvals have been published by addendum in accordance with the above procedure, the successful bidder may furnish no products of any trade names, brand names, or manufacturer's names except those designated in the contract documents.
- F. Any party who alleges that rejection of a submittal is a result of bias, prejudice, caprice, or error on the Architect may request a conference with a representative of the owner provided that the request for said conference, submitted in writing, shall have reached the owner at least five days prior to the date set for the opening of the bids, time being of the essence.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Hazardous Materials:
 - 1. A/E's Responsibility: Plans and specifications have been prepared by the A/E for Owner without the A/E having conducted investigation as to the presence of

asbestos or hazardous waste on the project. Not being a part of this contract, the A/E has not charged any fees and has not and will not advise Owner with regard to the detection and/or removal of asbestos or hazardous waste. The Owner is aware that asbestos or hazardous waste could be present and will make all decisions with regard to its removal. The removal of all hazardous materials and encapsulation of remaining surfaces is the sole responsibility of Owner.

2. If Contractor observes the existence of a friable material which must be disturbed during the course of his work, Contractor shall promptly notify Owner and Architect. The Owner shall make all arrangements regarding testing and removal or encapsulation of asbestos material if present. The Contractor shall not perform any work pertinent to the friable material prior to receipt of special instructions from Owner through Architect.
3. "Friable Material" is any material which can be crumbled, pulverized or reduced to a powder by hand pressure when dry.

B. Asbestos (ACBM)

1. Specifications written for equipment and materials in this division of the specifications are intended to eliminate any asbestos containing substance. The Contractor and his suppliers are hereby notified that **NO ASBESTOS CONTAINING PRODUCT IS PERMITTED**. If a product is listed in these specifications which contains asbestos, Contractor and his supplier shall so inform Architect immediately and shall not deliver such product to the project site until additional written instructions are received.
2. Upon completion of construction, and prior to final inspection, Contractor for work performed under this division of the specifications shall be required to provide a certificate to Architect in the following form:

CERTIFICATION FOR ASBESTOS CONTAINMENT

I/we _____ (Sub-Contractor), certify that there is no asbestos contained in materials provided and/or installed by us in _____ (Project/Building).

WITNESS _____ (Notary Public)

DATE: _____

CONTRACTOR: _____

BY: _____

TITLE: _____

3.2 PREPARATION

- A. Drawings are diagrammatic and show the general location of the equipment, raceway, and equipment, but are not to be scaled. All dimensions shall be verified at the building site. Prefabrication and/or installation of work from drawings shall be at Contractor's risk. Refer to Architectural plans for exact building dimensions and details.

- B. Space Conditions:
 - 1. All apparatus shall fit into the available spaces in the building and must be introduced into the building so as not to cause damage to the structure. Equipment larger than access to equipment spaces shall be disassembled into sub-assemblies for installation.
 - 2. Where deviations from the plans are required in order to conform to the space limitations, such changes shall be made at no additional cost to Owner and shall be subject to approval.
 - 3. All equipment requiring service shall be made accessible.
- C. Where new work is specified or shown connected to old work and materials are different from existing, Contractor shall request a clarification from Architect prior to performing the work.
- D. The demolition plan has been prepared to assist Contractor in determining the scope of demolition work and should not be construed to be all of the demolition required. The Contractor shall visit job site (after carefully reviewing the contract documents) and determine exact areas and quantities of existing materials to be removed to accomplish new construction.

3.3 INSTALLATION

- A. All equipment shall be installed in accordance with manufacturer's published installation instructions shipped with the equipment. In the event there is a discrepancy between these specifications or Drawings and the manufacturer's instructions, no work shall be performed until additional instructions are received.
- B. Route conduits and cable trays to avoid skylights, translucent, and transparent ceilings.
- C. Cutting and patching in connection with the installation shall be done by the trade whose work is to be cut. The Contractor shall lay out and install his work ahead of the work of other trades wherever possible.
- D. Where penetrations are made in fire rated partitions, walls, floors or ceilings during the course of electrical installation, these penetrations shall be restored to their intended fire ratings by the use of fittings or materials as approved by Underwriter's Laboratories for this purpose.
- E. See General Conditions.
- F. Fire Prevention Precautions in Cutting and Welding Areas: Conform to Article 2904 Fire Prevention Precautions, Georgia State Minimum Standard Fire Prevention Code (International Fire Code), 2012 Edition, with all Georgia State Amendments for all work involving cutting and welding.
- G. Seal sleeves and openings in exterior walls and mechanical room walls vaportight, watertight, or for smoke/fire protection as applicable. Refer to Section 07 8400 - Firestopping.
- H. Record Drawings:

1. After completion, any changes in the location of conduits, the connections of circuits, or any other changes from the contract documents shall be noted on a clean set of blue line white prints and delivered to Architect before final acceptance of work.

3.4 INTERFACE WITH OTHER WORK

- A. General: No roughing shall be done until roughing drawings and exact electrical demand of equipment is obtained. Notify Architect of any discrepancies.
- B. Mechanical:
 1. Review Tabulated List of Power Wiring Requirements of all Mechanical Equipment specified in Division 23 of the specifications. Conduit, conductor and breaker sizes shown for mechanical equipment are based upon the best available information on the equipment specified. The Contractor shall be allowed to provide electrical circuits compatible with the proposed mechanical equipment where the mechanical equipment conforms to Division 23 of the specifications, but does not conform to the electrical criteria of these contract documents. The Contractor shall submit the proposed electrical modifications to Architect for review prior to roughing. No additional costs to the contract will be allowed for these modifications.
 2. Provide control, program and interlock wiring as shown on Mechanical and/or Electrical drawings.
 3. Provide conduit, wiring, boxes, adaptors for equipment terminations and disconnect switches. Provide power wiring through primary control device.
 4. Starters, push-button stations, contactors, relays, limit and safety devices, and control items are specified in Division 26 of the specifications (except as shown in Motor Control Center). Unless otherwise noted, all starters shall be mounted between 24" and 80" above finished floor. Push-button stations shall be mounted at switch height except as noted.
 5. Owner Furnished Equipment: Provide conduit, wiring, boxes, adaptors for equipment terminations, and disconnect switches. Make all connections indicated.
 6. The information shown on the plans is based upon the best available information. Before performing any work on the site, Contractor shall contact the utility company(s) serving the facility and stake out all underground services. Notify Architect of any discrepancies.
- C. Laboratory Equipment Purchased by Owner, Installed by Contractor:
 1. Equipment planning, design, and layout is specialized, proprietary and coordinated with exact floor plan, structure, building systems, and finishes. Therefore the equipment supplier is responsible for providing detailed installation drawings including, but not limited to, drawings showing complete details on utilities and their routing. Revisions to these drawings are the responsibility of the supplier. The supplier shall provide notice of revisions to Owner, Architect and Contractor prior to Contractor's scheduled commencement of construction of this work.
 2. Since Owner is purchasing the equipment, Contractor shall coordinate with Owner to procure documents and to procure construction assistance from the equipment supplier regarding their system prior to any fabrication or installation work.
 3. The Contractor shall coordinate with the equipment supplier through Owner concerning proposed revision of equipment supplier design or comments to

accommodate site conditions. The Contractor shall not revise equipment supplier design.

4. The equipment supplier shall review the contract documents for compatibility of interface with the system(s) being furnished and provide comments to Architect and Contractor. The Contractor shall provide information such as shop drawings and material cuts to the equipment supplier for coordination review and comments.
5. Equipment drawings, by this reference, shall be incorporated into the contract documents. Equipment drawings shall be the latest Owner approved set at time of bidding.

3.5 EQUIPMENT BASES AND HOUSEKEEPING PADS

- A. Provide housekeeping and equipment pads where penetrations occur through any slab ON OR ABOVE GRADE in the electrical and data rooms. All electrical items that sit on the slab shall have housekeeping pads below. Rough up slab under bases before pouring concrete.
- B. Materials: Refer to Section 03 3000 - Cast-in-Place Concrete. Omit test cylinders for concrete poured under this section.
- C. Bases/Pads shall be rectangular with vertical sides 4 inches from centerline of anchor bolts or 2 inches from edges of equipment supports, whichever provides the larger dimension, side of equipment or base edge, unless otherwise noted. Housekeeping pads shall be minimum 4 inches thick.
- D. Radius Edge: 3/4 inch on edges and corners.
- E. Reinforcing: 6"x 6" 10/10 WWF at mid-depth of slab. (4 inch thick pads.)

3.6 STARTING EQUIPMENT AND SYSTEMS

- A. Adjust equipment for proper operation within manufacturers' published tolerances.
- B. Demonstrate proper operation of systems and equipment to Owner 's designated representative.

3.7 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. Instructions:
 1. Instruct operating personnel designated by Owner in operation and maintenance of systems prior to the request for final inspection. A manufacturer's service representative shall provide the instructions for each piece of equipment on system. A manufacturer's sales representative is not acceptable. (Instructor shall not be a sales person, but shall be one with service experience on a continuing basis, knowledgeable about the subject equipment.) The Owner will record (audio or video/audio) operating instructions given by the contractor to the operating personnel. Training shall be given on the following equipment:
 - a. Lighting Control System - 4 hrs.

- b. Generator (including transfer switches) - 4 hours
- c. Fire Alarm System - 4 hours, or as noted in the fire alarm section, whichever is longest.
2. The Contractor shall give notice to Architect not less than 60 days of the anticipated date of instruction to allow planning by Owner.
3. The Contractor shall request the instruction date not less than 15 days of the desired date for coordination with Owner. Operating manuals for the equipment/systems on which instructions are being given shall be in the possession of the operating personnel not less than 30 days prior to the date of instruction.
4. The Contractor shall give an orientation session to operating personnel for achieving familiarity (not instructions) of the systems approximately 5 days prior to the instruction date. The Contractor's representative giving instruction shall be knowledgeable in the equipment/systems to allow quality recordings by Owner.
5. Provide a signed statement from operating personnel certifying orientation and instructions have been received. Provide typed sequence of operation to be inserted in the maintenance manuals.

B. Completion of Work:

1. At final observation a test shall be made and the entire system shall be shown to be in working condition. The following shall be made available to personnel conducting the test:
 - a. Electrician with hand tools.
 - b. Accurate Voltmeter.
 - c. Clamp on Ammeter.
 - d. Test Lamp.
 - e. Phase Rotation Indicator.
 - f. Complete Electrical Specifications and Drawings with all addenda and revisions.
 - g. Pre-final Punch List indicating disposition of all items with initials of person confirming completion.
2. The Contractor shall demonstrate proper operation of the Fire Alarm System and Electric Generator System.
3. Before final observation or at final observation, Contractor shall present the following to Architect:
 - a. Finalized and corrected maintenance manuals.
 - b. Special systems certificates.
 - c. Record marked-up drawings.
 - d. Required test results.

3.8 CLEANING and PROTECTION

- A. All materials, equipment and electrical/telecommunications rooms shall be cleaned prior to Final Observation.
- B. Remove any stored materials. Vacuum interiors of all panelboards, switchboards, switchgear, transformers and any other electrical equipment.

- C. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish. Equipment which has been damaged beyond the point of retouching or has been retouched not to match shall be repainted to match factory finish.
- D. Chipped or scraped paint shall be retouched to match original finish.
- E. All equipment shall be free of dust, rust and stains prior to substantial completion.
- F. During Construction: Conduit openings shall be closed with caps or plugs. All equipment shall be covered and protected against water, dirt and chemical or mechanical injury. All equipment and material shall be stored in accordance with manufacturer's recommendations.

3.9 FINISHING ELECTRICAL EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint conduit and electrical equipment in exposed, public areas per Architect's instructions.
- C. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish shall be painted to prevent rust.
- D. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.

END OF SECTION 26 0510

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wire and cable for 600 volts and less.
- C. Wiring connectors.
- D. Electrical tape.
- E. Wire pulling lubricant.
- F. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 0536 - Cable Trays for Electrical Systems: Additional installation requirements for cables installed in cable tray systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 28 4600 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

- C. Field Quality Control Test Reports.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:

1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.

H. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.

I. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

J. Conductor Color Coding:

1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Isolated Ground, All Systems: Green with yellow stripe.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:

1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. Southwire Company: www.southwire.com/#sle.

B. Conductor Stranding:

1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Installed Underground: Type XHHW-2.

2.4 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 0526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 - 5. Aluminum Conductors: Use compression connectors for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.5 WIRING ACCESSORIES

- A. Electrical Tape:

1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
- B. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- C. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that raceway installation is complete and supported.
- E. Verify that field measurements are as shown on the drawings.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.
- B. Verify that interior of building has been protected from weather.

3.3 INSTALLATION

- A. Circuiting Requirements:
 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 2. When circuit destination is indicated without specific routing, determine exact routing required.
 3. Arrange circuiting to minimize splices.
 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.

6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway.
Dedicated neutral conductors are considered current-carrying conductors.
 8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
- G. Install conductors with a minimum of 12 inches of slack at each outlet.
- H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Color Code Legend: Provide identification label identifying color code for ungrounded conductors at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Grounding and bonding components.
- G. Building Grounding System consisting of Riser conductors and Grounding Plates located in Electrical rooms and Data closets.
- H. Provide all components necessary to complete the grounding system(s) consisting of:
 - 1. Existing metal underground water pipe.
 - 2. Metal frame of the building.
 - 3. Metal underground gas piping system.

1.2 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 0536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 03 2000 - Concrete Reinforcing.
- E. Section 03 3000 - Cast-in-Place Concrete.
- F. Section 26 0574 - Electrical Testing.
- G. Section 26 4113 - Lightning Protection.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- C. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2007.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2017.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide for active electrodes and connections.
- C. Project Record Documents: Record actual locations of components and grounding electrodes.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10

- feet at an accessible location not more than 5 feet from the point of entrance to the building.
- b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
- c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
- 3. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
- 4. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- E. Service-Supplied System Grounding:
 - 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 - 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- F. Separately Derived System Grounding:
 - 1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Generators, when neutral is switched in the transfer switch.
 - 2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 - 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 - 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.

5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

G. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
8. Provide bonding for metal building frame.

H. Communications Systems Grounding and Bonding:

1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.

I. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:

1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

- B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 0519:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify existing conditions prior to beginning work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle

or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 0553.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

2.2 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized or painted. All ferrous fasteners exposed to outside conditions and refrigerated spaces shall be coated with corrosion resistant, plated finish to prevent rust.
- C. Anchors and Fasteners:
1. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
 2. Steel Structural Elements: Use beam clamps, steel spring clips, or welded fasteners.
 3. Concrete Surfaces: Use expansion anchors.
 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
 5. Solid Masonry Walls: Use expansion anchors or preset inserts.
 6. Sheet Metal: Use sheet metal screws.
 7. Wood Elements: Use wood screws.

- D. All ferrous fasteners exposed to outside conditions and refrigerated spaces shall be coated with corrosion resistant, plated finish to prevent rust.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Design Professional.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION 26 0529

SECTION 26 0534 – CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Intermediate metal conduit (IMC).
- C. PVC-coated galvanized steel rigid metal conduit (RMC).
- D. Flexible metal conduit (FMC).
- E. Liquidtight flexible metal conduit (LFMC).
- F. Electrical metallic tubing (EMT).
- G. Rigid polyvinyl chloride (PVC) conduit.
- H. Liquidtight flexible nonmetallic conduit (LFNC).
- I. Conduit fittings.
- J. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Firestopping
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- C. Section 26 0529 - Hangers and Supports. .
- D. Section 26 0535 - Surface Raceways.
- E. Section 26 0553 - Identification for Electrical Systems.
- F. Section 26 0537 - Boxes.

1.3 REFERENCE STANDARDS

- A. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A); 2015.
- B. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.

- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- D. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2018.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- G. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- H. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- I. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
- J. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- K. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- L. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- M. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- N. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Design Professional of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide for metallic conduit, liquidtight flexible metal conduit, nonmetallic conduit, and fittings.
- C. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.6 ABBREVIATIONS

- A. GRS indicates galvanized rigid steel conduit also termed rigid steel conduit .
- B. RGS indicates galvanized rigid steel conduit also termed rigid steel conduit .
- C. GRC indicates galvanized rigid steel conduit also termed rigid steel conduit .
- D. IMC indicates intermediate metal conduit whether made of galvanized steel or aluminum. See Part 2 for specification.
- E. EMT indicates Electrical Metallic Tubing whether made of galvanized steel or aluminum. See Part 2 for specification.
- F. PVC40 indicates PVC electrical conduit, schedule 40.
- G. PVC80 indicates PVC electrical conduit, schedule 80.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies,

comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

- C. Underground:
 - 1. Under Slab on Grade: Use rigid PVC conduit.
 - 2. Exterior, Direct-Buried (lighting circuits): Use rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete (electrical service entrance): Use rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
 - 5. Where steel conduit emerges from concrete into soil, use corrosion protection tape to provide supplementary corrosion protection for a minimum of 4 inches on either side of where conduit emerges or use PVC-coated galvanized steel rigid metal conduit.
- D. Embedded Within Concrete:
 - 1. Within Slab on Grade: Not permitted.
 - 2. Within Slab Above Ground (within structural slabs only where approved by Structural Engineer): Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 3. Within Concrete Walls Above Ground: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.
- E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.
- L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
- M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
 - 1. Maximum Length: 6 feet.

- N. Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit.
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
 - 3. Maximum Length: 6 feet unless otherwise indicated.
 - 4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.

2.2 CONDUIT REQUIREMENTS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Minimum Conduit Size, Unless Otherwise Indicated:
 - 1. Branch Circuits: 1/2 inch (16 mm) trade size.
 - 2. Underground, Interior: 3/4 inch (21 mm) trade size.
 - 3. Underground, Exterior: 1 inch (27 mm) trade size.
- E. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 - 2. Republic Conduit: www.republic-conduit.com/#sle.
 - 3. Wheatland Tube Company: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 INTERMEDIATE METAL CONDUIT (IMC)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.

2. Republic Conduit: www.republic-conduit.com/#sle.
 3. Wheatland Tube Company: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- C. Fittings:
1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
1. Allied Tube & Conduit: www.alliedtube.com.
 2. Thomas & Betts Corporation: www.tnb.com.
 3. Robroy Industries: www.robroy.com.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- D. PVC-Coated Fittings:
1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- E. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.6 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
1. AFC Cable Systems, Inc: www.afcweb.com.
 2. Electri-Flex Company: www.electriflex.com.
 3. International Metal Hose: www.metalthose.com.
- B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- C. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

2.7 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 1. AFC Cable Systems, Inc: www.afcweb.com.
 2. Electri-Flex Company: www.electriflex.com.
 3. International Metal Hose: www.metalhose.com.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.

2.8 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 2. Republic Conduit: www.republic-conduit.com/#sle.
 3. Beck Manufacturing, Inc: www.beckmfg.com.
 4. Wheatland Tube Company: www.wheatland.com.
- B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use set-screw type.
 - a. Do not use indenter type connectors and couplings.

2.9 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 1. Cantex Inc: www.cantexinc.com/#sle.
 2. Carlon, a brand of Thomas & Betts Corporation: www.carlon.com/#sle.
 3. JM Eagle: www.jmeagle.com/#sle.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.10 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

- A. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.
- B. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for the type of conduit to be connected.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.
- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Install liquidtight flexible nonmetallic conduit (LFNC) in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.

2. When conduit destination is indicated without specific routing, determine exact routing required.
 3. Conceal all conduits unless specifically indicated to be exposed.
 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 5. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
 9. Arrange conduit to provide no more than 150 feet between pull points.
 10. Route conduits above water and drain piping where possible.
 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
- I. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use non-penetrating rooftop supports to support conduits routed across rooftops (only where approved).
- J. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up through concrete floors and are not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

K. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Design Professional.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

L. Underground Installation:

1. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
2. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.

M. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):

1. Maximum Conduit Size: 1 inch (27 mm) unless otherwise approved.
2. Secure conduits to prevent floating or movement during pouring of concrete.

- N. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 3000 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.
- O. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where conduits are subject to earth movement by settlement or frost.
- P. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits pass from outdoors into conditioned interior spaces.
 - 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- Q. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- R. Provide grounding and bonding in accordance with Section 26 0526.

3.3 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.4 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 26 0534

SECTION 26 0535 - SURFACE RACEWAYS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface raceway systems.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0534 - Conduit.
- C. Section 26 0537 - Boxes.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 2726 - Wiring Devices: Receptacles.
- F. Section 27 1005 - Structured Cabling for Voice and Data - Inside-Plant: Voice and data jacks.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.
- B. UL 5 - Surface Metal Raceways and Fittings; Current Edition, Including All Revisions.
- C. UL 5A - Nonmetallic Surface Raceways and Fittings; Current Edition, Including All Revisions.
- D. UL 111 - Outline of Investigation for Multioutlet Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate rough-in locations of outlet boxes provided under Section 26 0537 and conduit provided under Section 26 0534 as required for installation of raceways provided under this section.
 - 3. Verify minimum sizes of raceways with the actual conductors and components to be installed.

4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install raceways until final surface finishes and painting are complete.
2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. See Section 26 0510.
- B. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes, and accessories.
 1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Raceways, elbows, fittings and outlets shall be by the same manufacturer and designed for use together. All junction and device boxes shall be compatible with raceway.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

- A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 SURFACE RACEWAY SYSTEMS

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell-wiring.com.
 2. MonoSystems, Inc: www.monosystems.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.

- B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
- C. Surface Nonmetallic Raceways: Listed and labeled as complying with UL 5A.
- D. Multioutlet Assemblies: Listed and labeled as complying with UL 111.
- E. Surface Raceway System:
 - 1. Raceway Type: Two channel, painted steel.
 - 2. Length: As indicated on the drawings.
 - 3. Color: To be selected by Architect.
 - 4. Integrated Device Provisions:
 - a. Receptacles:
 - 1) Comply with Section 26 2726, except for finishes.
 - 2) Configuration: As indicated on the drawings.
 - 3) Color: Match raceway.
 - 4) Spacing: As indicated on the drawings.
 - b. Communications Outlets:
 - 1) Voice and Data Jacks: As specified in Section 27 1005.
 - 2) Configuration: As indicated on the drawings.
 - 3) Spacing: As indicated on the drawings.
 - 5. Basis of Design: Wiremold 4000 Series Steel, dual channel raceway.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.
- C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Furnish and install where indicated on plans.
- B. Install products in accordance with manufacturer's instructions.
- C. Install raceways in a neat and workmanlike manner in accordance with NECA 1.
- D. Runs shall be parallel or perpendicular to all walls and partitions.
- E. Connections shall be made to other types of raceway with fittings manufactured for that purpose.

- F. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
- G. Secure and support raceways in accordance with Section 26 0529 at intervals complying with NFPA 70 and manufacturer's requirements.
- H. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- I. Wireway Supports: Provide steel channel as specified in Section 26 0529.
- J. Close unused raceway openings.
- K. Provide grounding and bonding in accordance with Section 26 0526.

3.3 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.4 PROTECTION

- A. Protect installed raceways from subsequent construction operations.

END OF SECTION 26 0535

SECTION 26 0536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal cable tray systems:
 - 1. Metal wire mesh/basket cable tray.
- B. Firestopping within (not around) cable trays.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping - Firestopping around cable trays.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA VE 2 - Cable Tray Installation Guidelines; 2013, with Errata (2016).
- D. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others. Coordinate the work with other trades to avoid installation of obstructions within cable tray required clearances.
 - 2. Coordinate arrangement of cable tray with the dimensions and clearance requirements of the actual products to be installed.
 - 3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
 - 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

- B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.
- C. Sequencing:
 - 1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide data for tray, fittings, and accessories.
- C. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

- A. Provide basket, wire mesh type cable tray in exposed areas only. Cabling pathways above accessible ceilings shall be metallic j-hooks.
- B. Provide new cable tray system consisting of all required components, fittings, supports, accessories, etc. as necessary for a complete system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.
- E. Provide cable tray system and associated components suitable for use at indicated span/load ratings under the service conditions at the installed location.
- F. Unless otherwise indicated, specified span/load ratings are according to NEMA VE 1 (metal cable tray systems) or NEMA FG 1 (fiberglass cable tray systems) with safety factor of 1.5 and working load only (no additional concentrated static load).

- G. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values according to NEMA VE 1 (metal cable tray systems) or NEMA FG 1 (fiberglass cable tray systems) with applicable allowable tolerances.

2.2 METAL CABLE TRAY SYSTEMS

- A. Manufacturers:
 - 1. Metal Cable Tray System:
 - a. Cablofil, a brand of Legrand North America, Inc: www.legrand.us/#sle.
 - b. Cope, a brand of Atkore International Inc: www.copecabletray.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Mono-Systems
 - e. Hubbell (Wire Basket Tray)
- B. Comply with NEMA VE 1.
- C. Finishes:
 - 1. Zinc Electroplated Steel: Comply with ASTM B633.
- D. Metal Wire Mesh/Basket Cable Tray:
 - 1. Material: Zinc electroplated steel.
 - 2. Tray Depth: 2 inches.
 - 3. Mesh Spacing: 2 by 4 inches.
 - 4. Tray Width: 18 inches.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage cable tray system has been completed.
- B. Verify exact field dimensions and conditions before ordering tray or roughing.
- C. Verify that field measurements are as shown on drawings.
- D. Verify that the dimensions and span/load ratings of cable tray system components are consistent with the indicated requirements.
- E. Verify that mounting surfaces are ready to receive cable tray and associated supports.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install cable tray in accordance with NECA 1 (general workmanship), and NEMA VE 2.

- C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.
- D. Arrange cable tray to provide required clearances and maintain cable access.
 - 1. Minimum Clearance Above and Adjacent to Cable Tray: 12 inches.
- E. Install cable tray plumb and level, with sections aligned and with horizontal runs at the proper elevation.
- F. Metal Wire Mesh/Basket Cable Tray: Field fabricate fittings in accordance with manufacturer's instructions, using only manufacturer-approved connectors classified for bonding.
 - 1. Inside Radius of Fittings: 12 inches.
- G. Cable Tray Movement Provisions:
 - 1. Provide suitable expansion fittings where cable tray is subject to movement, including but not limited to:
 - a. Where cable tray crosses structural joints intended for expansion.
 - 2. Set gaps for expansion fittings in accordance with NEMA VE 2.
- H. Cable Provisions:
 - 1. Use suitable fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
 - 2. Use suitable drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
 - 3. Use suitable cable support fittings for long vertical cable tray runs with heavy cables.
- I. Provide end closures at unconnected ends of cable tray runs.
- J. Grounding and Bonding Requirements, in Addition to Requirements of Section 26 0526:
 - 1. Metal Cable Tray Systems: Use suitable bonding jumpers or classified connectors to provide electrical continuity.
 - 2. Provide suitable equipment grounding conductor in each cable tray, except where cable tray contains only multiconductor cables with integral equipment grounding conductors. Do not use metal cable tray system as sole equipment grounding conductor.
 - a. Equipment Grounding Conductor for Aluminum Cable Tray: Use insulated copper conductor only; do not use bare copper conductor.
 - b. Minimum Equipment Grounding Conductor Size: 2 AWG copper.
 - c. Bond equipment grounding conductor to each cable tray section using suitable listed ground clamps. Separate bonding jumpers are not required where properly bonded equipment grounding conductor provides equivalent continuity.
- K. Conduit Termination:
 - 1. Use listed cable tray conduit clamps (evaluated for bonding connection) to terminate conduits at cable tray.
 - 2. Provide insulating bushing at conduit termination to protect cables.
 - 3. Provide independent support for conduit.

- L. Identification Requirements, in Addition to Those Specified in Section 26 0553.
- M. Install cable tray covers where indicated and as follows:
- N. Support trays in accordance with Section 26 0529. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 10 ft maximum.
- O. Size all thread hanger rods per manufacturer's recommendations.
- P. Connections to supports shall be made with fittings and hardware specifically designed for the purpose. Disassembly of connection shall be welded.
- Q. Provide a support within two feet of any termination (end of run).
- R. Provide sway bracing of horizontal runs at elbows and terminations. Sway brace shall be a one piece channel attached between the midpoint of the elbow radius (or end-point of termination) and the nearest building structural component.
- S. Make attachments to structure only. Do not attach to piping, ductwork, or non-structural walls, floors, etc.
- T. Use expansion connectors where required.
- U. Cable tray shall not pass through a fire or smoke rated partition. Stop the cable tray within 4 inches of both sides of the fire/smoke partition and provide 4" Rigid Metal Conduit sleeves (number as required to match capacity of cable tray using 40% fill rule) through the rated partition. Seal around sleeves and inside sleeves around cables in accordance with Section 8400- 07 8413.
- V. Install warning signs at 50 feet centers along cable tray, located to be visible.

3.3 FIELD QUALITY CONTROL

- A. Inspect cable tray system for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective cable tray system components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Remove dirt and debris from cable tray.

- B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 0536

SECTION 26 0537 – BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Wall and ceiling outlet boxes.
- D. Floor boxes.
- E. Pull and junction boxes.

1.2 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0534 - Conduit:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- E. Section 26 2726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- F. Section 27 1005 - Structured Cabling for Voice and Data - Inside-Plant: Additional requirements for communications systems outlet boxes.

1.3 DESIGN INTENT

- A. Careful coordination is required with backbox placement. In general, unless noted otherwise outlets and switches shall be placed as described on the drawings.
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

- A. See Section 26 0510.
- B. Provide cut sheets on floor outlet boxes only.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70, National Electrical Code; 2017 Edition.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.

7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
12. Wall Plates: Comply with Section 26 2726.

- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.2 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
 - a. Boxes and covers shall not be less than 1/16 inch thick.
 - b. Box shall be anchored in place.
 - c. Unless otherwise specified, ceiling outlet boxes need not be provided with plaster rings and shall be minimum two inches (2") deep. Boxes shall be provided with blank covers.
 2. Concrete Ceiling Boxes: Concrete type.
 3. Switch and wall receptacles outlet boxes in plaster walls shall be four inches (4") square.
 4. In exposed masonry or tile walls, four inch (4") square boxes with deep plaster covers shall be used.
- B. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- C. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.3 PULL AND JUNCTION BOXES

- A. All pullboxes and junction boxes shall be sized in accordance with the National Electrical Code.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 2716.

- D. Surface Mounted Exposed Boxes: Boxes shall be corrosion resistant cast iron in wet locations. Use solid steel boxes with no knockouts in dry locations. Holes for raceways shall be drilled on the job.
- E. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and galvanized steel cover/screws.
- F. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.
- E. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in. In General, Data outlets for anything other than wireless access points or cameras should always have receptacles adjacent. If not shown this way, notify the architect prior to any rough in. A receptacle should always be adjacent to a data/catv outlet.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.

- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 3100 as required where approved by the Architect.
 2. Unless dimensioned, box locations indicated are approximate.
 3. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726.
 - b. Communications Systems Outlets: Comply with Section 27 1005.
 4. Locate boxes so that wall plates do not span different building finishes.
 5. Locate boxes so that wall plates do not cross masonry joints.
 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0534.
 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- O. Close unused box openings.
- P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- Q. Provide grounding and bonding in accordance with Section 26 0526.
- R. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- S. Provide outlet boxes for lighting fixtures, wall switches, wall receptacles, telecommunications equipment, protection equipment, antenna, and all equipment.
- T. Coordinate installation of outlet boxes for equipment connected under Section 26 2717.
- U. Unless otherwise indicated wall outlet boxes shall be placed with center lines at distances above the finished floor (except at casework) as labeled on the drawings:
 1. Fire Alarm Pull Stations: 48" to the operable handle.
 2. Fire Alarm Visual or Horn/Visual: 80" or 6" below ceiling - conform to lowest mounting. Note that this measurement is to the BOTTOM of the lens on the device.
- V. The approximate locations of outlets are shown on the plans. The exact locations shall be determined at the building. The right is reserved to change the exact location of any outlet a maximum of 10 feet before it is permanently installed without additional cost.
- W. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
- X. Maintain headroom and present neat mechanical appearance.
- Y. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- Z. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

- AA. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- AB. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- AC. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- AD. Where outlets are shown above cabinets and casework, the outlets shall be mounted so the bottom of the device plates will be 1 to 3 inches above the backsplash.
 - 1. Where outlets of different levels are shown adjacent, they shall be installed in one vertical line. Outlets shown back to back on a common wall shall be offset a minimum of 10 inches to dampen sound transmission through the wall. On all walls with 1 hour or greater fire rating, "back to back" outlets shall be minimum 24 inches apart with a stud between outlets for gypboard constructed partition.
 - 2. Where the mounting height of an outlet is not shown on the plans or specifications, the contractor shall contact the architect for exact mounting height requirements.
 - 3. At locations where two or more devices are shown adjacent and at the same mounting height, they shall be installed in one outlet box and covered with one face plate.
- AE. Where outlets are installed in unfinished block or tile partitions, they shall be installed at the points in the tile to permit the face plate to cover the rough opening. The horizontal and vertical locations indicated may be altered to permit doing this. However, contractor shall check the Architectural drawings to prevent conflicts when shifting location. Where outlets are shown back to back on a common wall, they shall be offset 10" to avoid sound transmission.
- AF. Outlets in Poured-in-Place Concrete: A six by six by three inch (6"X6"X3") deep wood box shall be placed in the form before the concrete is poured. This box shall be removed before waterproofing is applied. Install outlet and grout around the box. Boxes shall be set so that cover plates are flush.
- AG. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- AH. Use flush mounting outlet box in finished areas.
- AI. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
- AJ. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- AK. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- AL. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- AM. Use adjustable steel channel fasteners for hung ceiling outlet box.
- AN. Do not fasten boxes to ceiling support wires.

- AO. Support boxes independently of conduit. Provide threaded rods, screws, bolts, toggle bolts, etc. for support. Do not use clips or other hardware to attach boxes to ceiling grids.
- AP. Use gang box where more than one device is mounted together. Do not use sectional box.
- AQ. Use two gang box with plaster ring for single device outlets.
- AR. Floor boxes shall be set and readjusted to provide a smooth surface, conforming to elevation and slope of the surrounding finished floor. In carpeted areas, flanges shall be installed to protect carpet edges. Provide tapped holes in all boxes as determined by conduit entering box.
- AS. A carpet flange shall be installed on floor boxes in all carpeted areas. In non-carpeted areas, a beveled carpet flange shall be installed with the entire perimeter in contact with the floor finishing material, and caulking compound shall be provided beneath the flange to keep water from seeping under the flange.
- AT. Set floor boxes level.
- AU. Boxes for any specialty devices such as speakers, fire alarm horns and stations, and program signals shall be obtained from the equipment manufacturer.
- AV. Trim rings around floorboxes of any type must be less than 1/4". Greater than this height will require re-working by the contractor at no cost to the Owner or Design Professional.

3.3 ADJUSTING

- A. Adjust floor boxes flush with finish flooring material. Minimize floorbox height to reduce tripping hazard. Tile and carpet must be cut in order for the box edge to come in contact with the floor substrate - the box shall not rest on the tile or carpet.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

3.4 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

END OF SECTION 26 0537

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Voltage markers.
- D. Underground warning tape.
- E. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 09 9000 - Painting and Coating.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- C. Section 26 0536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.
- D. Section 26 0573 - PROTECTIVE DEVICE COORDINATION STUDY: Arc flash hazard warning labels.

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2018.
- E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:

1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Use identification nameplate to identify main overcurrent protective device.
 - 5) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
 - d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
 - e. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
4. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Service equipment.

- b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
 - 5. Arc Flash Hazard Warning Labels: Comply with Section 26 0573.
 - 6. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data:
 - 1) Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
 - 2) Include the following information:
 - (a) Arc flash protection boundary.
 - (b) Incident energy.
 - (c) Hazard/risk category.
 - (d) PPE (personnel protective equipment) requirements.
 - (e) Nominal voltage.
 - (f) Shock hazard condition.
 - (g) Limited approach boundary.
 - (h) Restricted approach boundary.
 - (i) Prohibited approach boundary.
 - (j) Equipment identification.
 - (k) Date calculations were performed.
- B. Identification for Conductors and Cables:
- 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- C. Identification for Raceways:
- 1. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
 - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Color Code:
 - (a) Emergency Power System: Yellow.
 - (b) Fire Alarm System: Red.
 - 2) Field-Painting: Comply with Section 09 9000.
 - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
 - 4) Hand-write on the end of spare conduit the location of the terminating end if not within sight.
- D. Identification for Boxes:
- 1. Use voltage markers or color coded boxes to identify systems other than normal power system.

- a. Color-Coded Boxes: Field-painted in accordance with Section 09 9000 per the same color code used for raceways.
 - 1) Emergency Power System: Yellow.
 - 2) Fire Alarm System: Red.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

E. Identification for Devices:

1. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
2. Use identification label or engraved wallplate to identify load controlled by the light switch.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
 - a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
5. Color:
 - a. Normal Power System: White text on black background.

- D. Format for Receptacle Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Power source and circuit number or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background. RED on Clear for Emergency.
- E. Format for Light Switch Identification:
 - 1. Minimum Size: 3/8 inch by 1.5 inches.
 - 2. Legend: Load controlled or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch.
 - 5. Color: Black text on clear background. RED on Clear for Emergency.

2.3 VOLTAGE MARKERS

- A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
 - 1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 3. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
 - 1. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
- E. Color: Black text on orange background unless otherwise indicated.

2.4 UNDERGROUND WARNING TAPE

- A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:

2.5 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

- B. Warning Signs:
 - 1. Materials:
 - 2. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION 26 0553

SECTION 26 0573 - PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Short-circuit study.
- B. Protective device coordination study.
- C. Arc flash and shock risk assessment.
 - 1. Includes arc flash hazard warning labels.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 2. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Submit study reports prior to or concurrent with product submittals.
 - 2. Do not order equipment until matching study reports and product submittals have both been evaluated by Architect.

1.3 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Study preparer's qualifications.
- C. Study reports, stamped or sealed and signed by study preparer.
- D. Study Report: Submit short circuit and protective device studies as specified, prior to submission of product data submittals or ordering or fabrication of protective devices.
 - 1. Evaluation of product data submittals by Architect will not commence until acceptable studies have been submitted.
 - 2. Include stamp or seal and signature of preparing engineer.
- E. Field Engineer Qualifications.
- F. Field Inspection Report: Show final adjusted settings of protective devices.
- G. Certificates: Prior to Material Completion, certify that field adjustable protective devices have been set in accordance with requirements of protective device analysis.

- H. Project Record Documents: Revise protective device study as required to show as-built conditions.
 - 1. Submit not less than 60 days prior to final inspection of electrical system.
 - 2. Include hard copies with operation and maintenance data submittals.
 - 3. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.4 POWER SYSTEM STUDIES

- A. Scope of Studies:
 - 1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).
 - 2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
- B. General Study Requirements:
 - 1. Comply with NFPA 70, National Electrical Code; 2017 Edition.
 - 2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.
- C. Data Collection:
 - 1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
 - a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
 - 1) Obtain up-to-date information from Utility Company.
 - b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
 - c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
 - d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
 - e. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:

1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
 - a. Maximum utility fault currents.
 - b. Maximum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:

1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).
3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination while providing adequate protection for equipment and conductors.

F. Arc Flash and Shock Risk Assessment:

1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
 - a. Maximum and minimum utility fault currents.
 - b. Maximum and minimum motor contribution.
 - c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:

1. General Requirements:
 - a. Identify date of study and study preparer.
 - b. Identify study methodology and software product(s) used.
 - c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
 - d. Identify base used for per unit values.
 - e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
 - f. Include conclusions and recommendations.
2. Short-Circuit Study:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
 - 2) Fault point X/R ratio.

- 3) Associated equipment short circuit current ratings.
 - b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
 - a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
 - b. For each graph include (where applicable):
 - 1) Partial single-line diagram identifying the portion of the system illustrated.
 - 2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.
 - 3) Conductors: Damage curves.
 - 4) Transformers: Inrush points and damage curves.
 - 5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.
 - 6) Motors: Full load current, starting curves, and damage curves.
 - 7) Capacitors: Full load current and damage curves.
 - c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.
 - 1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 2) Include ground fault pickup and delay.
 - 3) Include fuse ratings.
 - 4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
 - d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.
4. Arc Flash and Shock Risk Assessment:
 - a. For each scenario, identify at each bus location:
 - 1) Calculated incident energy and associated working distance.
 - 2) Calculated arc flash boundary.
 - 3) Bolted fault current.
 - 4) Arcing fault current.
 - 5) Clearing time.
 - 6) Arc gap distance.
 - b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.
 - c. Identify locations where the calculated maximum incident energy exceeds 40 calories per sq cm.

1.5 PROTECTIVE DEVICE STUDY

- A. Analyze the specific electrical and utilization equipment (according to NEC definition), the actual protective devices to be used, and the actual feeder lengths to be installed.
 1. Scope of Studies: All new distribution wiring and equipment, from primary source to buses and branch circuit panelboards.
 2. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.

3. Report: State the methodology and rationale employed in making each type of calculation; identify computer software package(s) used.
- B. One-Line Diagrams: Prepare schematic drawing of electrical distribution system, with all electrical equipment and wiring to be protected by the protective devices; identify nodes on the diagrams for reference on report that includes:
1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the main switchboard bus and all downstream devices containing protective devices.
 2. Breaker and fuse ratings.
 3. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 4. Identification of each bus, with voltage.
 5. Conduit materials, feeder sizes, actual lengths, and X/R ratios.
- C. Short Circuit Study: Calculate the fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
1. Show fault currents available at key points in the system down to a fault current of 7,000 A at 480 V and 208 V.
 2. Include motor contributions in determining the momentary and interrupting ratings of the protective devices.
 3. Primary Fault Level Assumptions: Obtain data from utility company.
 4. Report: Include all pertinent data used in calculations and for each device include:
 - a. Device identification.
 - b. Protective device.
 - c. Device rating.
 - d. Calculated short circuit current, asymmetrical and symmetrical, and ground fault current.
- D. Coordination Study: Perform an organized time-current analysis of each protective device in series from the individual device back to the primary source, under normal conditions, alternate operations, and emergency power conditions. Analysis shall include ground fault devices.
1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
 2. Plot the specific time-current characteristics of each protective device on log-log paper.
 3. Organize plots so that all upstream devices are clearly depicted on one sheet.
 4. Also show the following on curve plot sheets:
 - a. Device identification.
 - b. Voltage and current transformer ratios for curves.
 - c. 3-phase and 1-phase ANSI damage curves for each transformer.
 - d. No-damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum short circuit cutoff point.
 - h. Simple one-line diagram for the portion of the system that each curve plot illustrates.

- i. Software report for each curve plot, labeled for identification.
 5. Emergency Systems: The coordination study shall include coordination of all emergency system overcurrent devices with all supply side overcurrent protective devices. Make necessary adjustments or recommendations for alternate equipment to comply with the 2017 National Electrical Code.
 6. Elevators: In buildings with more than one elevator supplied by a single feeder, the overcurrent protective devices in each disconnecting means shall be selectively coordinated with any other supply side overcurrent protective devices, including any disconnect or circuit breaker located at an emergency generator. Make necessary adjustments or recommendations for alternate equipment to comply with the 2017 National Electrical Code.
- E. Analysis: Determine ratings and settings of protective devices to minimize damage caused by a fault and so that the protective device closest to the fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
 2. Identify any equipment that is underrated as specified.
 3. Identify existing protective devices that will not achieve required coordination and cannot be field adjusted to do so.
 4. Identify specified protective devices that will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost to Owner and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor changes include different trip sizes in the same frame, time curve characteristics of induction relays, CT ranges, etc.
 5. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve a change to the contract sum.
 6. In all cases where adequate protection or coordination cannot be achieved at no extra cost to Owner, provide a discussion of alternatives and logical compromises for best achievable coordination.
 7. Do not order, furnish, or install protective devices that do not meet performance requirements unless specifically approved by Architect.
- F. Protective Device Rating and Setting Chart: Summarize in tabular format the required characteristics for each protective device based on the analysis; include:
1. Device identification.
 2. Relay CT ratios, tap, time dial, and instantaneous pickup.
 3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
 4. Fuse rating and type.
 5. Ground fault pickup and time delay.
 6. Input level and expected response time at two test points that are compatible with commonly available test equipment and the ratings of the protective device.
 7. Highlight all devices that as furnished by Contractor will not achieve required protection.
- G. Arc Flash Hazard Study: Provide an Arc Flash Hazard Study for the electrical distribution system shown on the power riser diagram. The intent of the Arc Flash Hazard Study is to

determine hazards that exist at each major piece of electrical equipment shown on the power riser diagram. This includes switchboards, panelboards, automatic transfer switches, and transformers.

1. The study shall be performed after the short circuit and protective device coordination study has been completed based upon IEEE Std. 1584, "IEEE Guide for Performing Arc Flash Hazard Calculations".
2. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.
3. The study shall be in accordance with the latest adopted versions of NFPA 70E, OSHA 29-CFR, Part 1910 Subpart S and IEEE 1584 Standards.
4. The study shall determine the following:
 - a. Flash Hazard Protection Boundary
 - b. Limited Approach Boundary
 - c. Restricted Boundary
 - d. Prohibited Boundary
 - e. Incident Energy Level
 - f. Required Personal Protective Equipment (PPE) Class
 - g. Type of Fire Rated Clothing
5. The study shall include creation of Arc Flash Hazard Warning Labels. These labels serve as a guide to assist technicians and others in the selection of proper PPE when working around exposed and energized conductors. Include the bus name, system operating voltage, and date of issue. Labels shall be printed in color on adhesive backed labels.
6. The Contractor shall install the warning labels.

1.6 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years' experience in the preparation of studies of similar type and complexity using specified computer software.
- B. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years' experience in work of this type, and employing professional electrical engineer licensed in to perform the studies.
- C. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
- D. The Contractor's Responsibility: Provide all project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, and actual circuit lengths.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

- A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
 1. Materials: Comply with Section 26 0553.

2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
 - a. Include orange header that reads "WARNING" where calculated incident energy is less than 40 calories per square cm.
 - b. Include red header that reads "DANGER" where calculated incident energy is 40 calories per square cm or greater.
 - c. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
 - d. Include the following information:
 - 1) Arc flash boundary.
 - 2) Available incident energy and corresponding working distance.
 - 3) Site-specific PPE (personnel protective equipment) requirements.
 - 4) Nominal system voltage.

2.2 PROTECTIVE DEVICES

- A. Provide protective devices of ratings and settings as required so that the protective device closest to the fault will open first.
- B. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of this analysis.

PART 3 EXECUTION

3.1 INSTALLATION

3.2 INSTALLATION

- A. The contractor shall provide a permanent label on the Service Entrance Equipment indicating the available fault current rating at that location per the requirements of the National Electrical Code.
- B. Install all labels from the Arc Flash Hazard Analysis at each piece of electrical equipment.

3.3 FIELD QUALITY CONTROL

- A. Adjust equipment and protective devices for compliance with studies and recommended settings.
- B. Notify Architect of any conflicts with or deviations from studies. Obtain direction before proceeding.
- C. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the installed protective devices to conform to requirements determined by the coordination analysis.
- D. Adjust installed protective devices having adjustable settings to conform to requirements determined by the coordination analysis.

- E. Submit report showing final adjusted settings of all protective devices.

END OF SECTION 26 0573

SECTION 26 0574 - ELECTRICAL TESTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Infrared Scan of Electrical Gear.

1.2 SUBMITTALS

- A. See Section 260510 - General Electrical Requirements for submittal procedures.
- B. Electrical Testing Firm Qualifications.
- C. Provide a sketch and written description of the testing procedures to be utilized for review by Architect at least six (6) weeks prior to performing the test.
- D. The test report shall indicate the measure impedance to ground for the ground bus of the main service entrance switchboard and a list of all dry type transformers, panelboards, and distribution panelboards with a statement concerning the installation at each ground and neutral bus.
- E. Provide test report as described in Insulation Testing.
- F. Project Record Documents:
 - 1. Submit not less than 60 days prior to final inspection of electrical system.
 - 2. Include copy of all test reports and a written description of what actions were taken to resolve any problems encountered.
 - 3. Types and dates for calibration of all instruments shall be listed in the final test reports.

1.3 QUALITY ASSURANCE

- A. Testing Firm Qualifications: Electrical testing agency regularly engaged in the tests specified herein, with at least 5 years' experience in work of this type.
- B. All test results shall be certified by a professional electrical engineer licensed in the State of Georgia.
- C. All test results shall bear the seal and signature of the certifying electrical engineer.
- D. The subcontractor performing the services in this section shall review the Contract Documents and existing conditions prior to performing any tests.

PART 2 PRODUCTS

2.1 INSTRUMENTS

- A. Instruments for which calibration is periodically required and which will be utilized for testing the electrical system and equipment shall have been calibrated within a period of six (6) months prior to the testing.

PART 3 EXECUTION

3.1 INFRARED SCAN

- A. Scan the interiors of all panelboards, switchboards, dry type transformers, and motor control centers using optical instrumentation sensitive to the infrared wave length to observe, catalog, and analyze thermal variations.
- B. During the scan (survey), each problem observed shall be recorded with both a thermogram (photograph of the thermal gradient) and a standard color photograph.
- C. The thermograms and photographs shall be identified and correlated with a verbal description of the observed anomaly.
- D. Anomalies shall be categorized as Class 1, 2, or 3 as follows:
 - 1. Class 1 anomalies shall be for items with a minor temperature differential of less than 20 degrees Celsius.
 - 2. Class 2 anomalies shall be for items with a temperature differential greater than 20 degrees Celsius but less than 80 degrees Celsius.
 - 3. Class 3 anomalies shall be for items with a temperature differential greater than 80 degrees Celsius.

END OF SECTION 26 0574

SECTION 26 2200 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General purpose transformers.

1.2 RELATED REQUIREMENTS

- A. Section 26 0574 - Electrical Testing.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0534 - Conduit: Flexible conduit connections.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.
- B. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- D. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; 2002.
- E. NFPA 70 - National Electrical Code; 2017 Edition.
- F. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
- G. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors required for mounting of transformers.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual locations of transformers.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D (basis of design).
- B. ABB/GE.
- C. Eaton.
- D. Siemens.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below

saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
 - 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.
- F. Winding Taps:
 - 1. Less than 3 kVA: None.
 - 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 - 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
 - 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- H. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
- I. Sound Levels: Standard sound levels complying with NEMA ST 20.
- J. Mounting Provisions:
 - 1. Less than 15 kVA: Suitable for wall mounting.
 - 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.

3. Larger than 75 kVA: Suitable for floor mounting.
- K. Transformer Enclosure: Comply with NEMA ST 20.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 4. Provide lifting eyes or brackets.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install transformers in accordance with manufacturer's instructions.
- B. Use flexible conduit, under the provisions of Section 26 0534, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- D. Set transformers plumb and level.
- E. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer. Provide plywood backboard for mounting and reinforce wall as required to support the transformer.
- F. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
 1. Pads shall be rubber in shear type isolating pads under each transformer corner. Bolt the isolator to the transformer and to the floor or support.
- G. Mount trapeze-mounted transformers as indicated. See mounting detail on drawings.
- H. Provide seismic restraints.
- I. Provide grounding and bonding in accordance with Section 26 0526.

- J. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- K. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.
- L. Install transformer identification nameplate in accordance with Section 26 0553.
- M. Coordinate transformer suspension with Architect to minimize noise transmission. In each suspension rod, provide a spring hanger isolator.

3.3 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.4 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2200

SECTION 26 2413 – SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.
- B. Overcurrent protective devices for switchboards.
- C. Switchboard accessories.

1.2 RELATED REQUIREMENTS

- A. Section 26 0574 - Electrical Testing.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0573 - PROTECTIVE DEVICE COORDINATION STUDY: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- E. Section 26 4300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- E. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- F. UL 891 - Switchboards; Current Edition, Including All Revisions.
- G. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:

1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchboard prior to fabrication.
4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of all equipment and components.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; and switchboard instrument details.
- D. Test Reports: Indicate results of factory production tests.
- E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Project Record Documents: Record actual locations of switchboards.
- G. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
- B. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D (basis of design).
- B. ABB/GE.
- C. Eaton.
- D. Siemens.

2.2 SWITCHBOARDS

- A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.
- D. Front-Connected Switchboards:
 - 1. Main Device(s): Individually-mounted.
 - 2. Feeder Devices: Panel/group-mounted.
 - 3. Arrangement: Front accessible only (not rear accessible), rear aligned.
 - 4. Gutter Access: Bolted covers.
- E. Service Entrance Switchboards:
 - 1. Listed and labeled as suitable for use as service equipment according to UL 869A.
 - 2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
 - 3. Comply with Utility Company requirements for electrical service.
- F. Short Circuit Current Rating:

1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
 2. Minimum Rating: 65,000 rms symmetrical amperes.
- G. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.
- H. Bussing: Sized in accordance with UL 891 temperature rise requirements.
1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
 2. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 3. Phase and Neutral Bus Material: Copper.
 4. Ground Bus Material: Copper.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
1. Line Conductor Terminations:
 - a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - b. Main and Neutral Lug Type: Mechanical.
 2. Load Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - b. Lug Type:
 - 1) Provide mechanical lugs unless otherwise indicated.
 - 2) Provide compression lugs where indicated.
- J. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 2. Finish: Manufacturer's standard unless otherwise indicated.
- K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list switchboards as a complete assembly including surge protective device.
- L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
1. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - a. Use zero sequence or residual ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
- M. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

- N. Owner Metering:
1. Provide microprocessor-based digital electrical metering system including all instrument transformers, wiring, and connections necessary for measurements specified.
 2. Measured Parameters:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase and neutral.
 - c. Frequency (Hz).
 - d. Real power (kW): For each phase, 3-phase total.
 - e. Reactive power (kVAR): For each phase, 3-phase total.
 - f. Apparent power (kVA): For each phase, 3-phase total.
 - g. Power factor.
 3. Meter Accuracy: Plus/minus 1.0 percent.
 4. Features:
 - a. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
- O. Distribution Section Devices: Group Mounted.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Circuit Breakers:
1. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 1) Provide thermal magnetic circuit breakers unless otherwise indicated.
 - b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.
 - d. Provide the following circuit breaker types where indicated:

- 1) 100 Percent Rated Circuit Breakers: Listed for application within the switchboard where installed at 100 percent of the continuous current rating.
- e. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
3. Insulated Case Circuit Breakers (Main Breaker Only):
 - a. Description: Quick-make, quick-break, trip-free circuit breakers with two-step stored energy closing mechanism; standard 80 percent rated unless otherwise indicated; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated on the drawings.
 - b. Construction:
 - 1) Provide fixed-mount circuit breakers unless otherwise indicated.
 - c. Minimum Interrupting Capacity:
 - 1) 65,000 rms symmetrical amperes at 480 VAC.
 - d. Trip Units: Solid state, microprocessor-based, true rms sensing.
 - 1) Provide the following field-adjustable trip response settings:
 - (a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - (b) Long time delay.
 - (c) Short time pickup and delay.
 - (d) Instantaneous pickup.
 - (e) Ground fault pickup and delay where ground fault protection is indicated.
 - e. Provide the following features and accessories where indicated or where required to complete installation:
 - 1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive switchboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

- C. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
- D. Provide required support and attachment components in accordance with Section 26 0529.
- E. Install switchboards plumb and level.
- F. Unless otherwise indicated, mount switchboards on properly sized 8" high concrete pad constructed in accordance with Section 03 3000.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Install all field-installed devices, components, and accessories.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- K. Provide filler plates to cover unused spaces in switchboards.
- L. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- M. The building electrical power riser shall be framed behind clear plastic and mounted on the wall in the Main Electrical Room.

3.3 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of switchboard covers and doors.

3.4 CLEANING

- A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred surfaces to match original factory finish.

END OF SECTION 26 2413

SECTION 26 2416 – PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0574 - Electrical Testing.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- D. Section 26 0529 - Hangers and Supports for Electrical Systems.
- E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 0573 - PROTECTIVE DEVICE COORDINATION STUDY: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- G. Section 26 2417- Surge Protective Devices.

1.3 REFERENCE STANDARDS

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- D. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- E. UL 67 - Panelboards; Current Edition, Including All Revisions.
- F. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

- G. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
 1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- F. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D (basis of design).
- B. ABB/GE.
- C. Eaton.
- D. Siemens.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- C. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- D. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- E. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- H. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

- I. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 4300, list and label panelboards as a complete assembly including surge protective device.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 1. Phase and Neutral Bus Material: Aluminum.
 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 1. Provide bolt-on type.
- E. Enclosures:
 1. Provide surface-mounted enclosures unless otherwise indicated.
 2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 2. Phase and Neutral Bus Material: Aluminum.
 3. Ground Bus Material: Aluminum.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 1. Provide surface-mounted or flush-mounted enclosures as indicated.

2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Provide compression lugs where indicated.
 - c. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- C. Provide required supports in accordance with Section 26 0529.
- D. Install panelboards plumb.
- E. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- F. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- G. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- H. Provide grounding and bonding in accordance with Section 26 0526.
- I. Install all field-installed branch devices, components, and accessories.
- J. Provide filler plates to cover unused spaces in panelboards.
- K. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Fire detection and alarm circuits.
- L. Identify panelboards in accordance with Section 26 0553.

3.3 FIELD QUALITY CONTROL

- A. Test GFCI circuit breakers to verify proper operation.
- B. Test shunt trips to verify proper operation.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2416

SECTION 26 2417 - SURGE PROTECTIVE DEVICES (SPDS)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low Voltage AC Surge Protection for Electrical Distribution Systems

1.2 DEFINITIONS

- A. Where items are shown as "lightning arrestor", "lightning suppressor", "surge arrestor", "arrestor", "suppressor", "transient voltage surge suppressor" (TVSS), or "surge suppressor", provide Surge Protective Device (SPD).

1.3 SUBMITTALS

- A. See Section 26 0510- General Electrical Requirements, for submittal procedures.
- B. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL). Compliance may be in the form of a file number that can be verified on UL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).
- C. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- D. Product Data: Provide data sheets for each different component to be used.
 - 1. Provide a list of device locations with the corresponding device type proposed.
 - 2. Show that Surge Protective Devices (SPDs) and associated components are manufactured in the United States of America.
- E. Submit a copy of the written guarantee.
- F. Provide a letter stating that the manufacturer shall provide unit replacement within 48 hours of notification by Owner with or without prior receipt of damaged parts.
- G. Operating & Maintenance Data:
 - 1. Submit the service organization name and phone number.
 - 2. Operation and maintenance manuals shall be provided with each SPD shipped.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

- B. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.5 WARRANTY

- A. The manufacturer shall provide a full five (5) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.
- B. Warranty shall begin upon the date of final building acceptance by the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. APT
- B. Liebert
- C. Square D
- D. General Electric
- E. Eaton
- F. Siemens
- G. Surge Suppression, Inc.

2.2 VOLTAGE SURGE SUPPRESSION - GENERAL

- A. Electrical Requirements:
 - 1. Unit Operating Voltage - Refer to drawings for operating voltage and unit configuration.
 - 2. Maximum Continuous Operating Voltage (MCOV) - The MCOV shall not be less than 125% of the nominal system operating voltage.
 - 3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
 - 4. Protection Modes - The SPD must protect all modes of the electrical system being utilized. The required protection modes are:
 - a. Line-to-Neutral
 - b. Line-to-Ground
 - c. Line-to-Line
 - d. Neutral-to-Ground

5. Nominal Discharge Current (In) - All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) - The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:
 - a. 480Y/277 Volts:
 - 1) L-N, L-G, N-G = 1200
 - 2) L-L = 2000
 - b. 208Y/120 Volts:
 - 1) L-N, L-G, N-G = 800
 - 2) L-L = 1200

B. SPD Design:

1. Maintenance Free Design - The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform - The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter - Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 30 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections - No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics - Each SPD shall provide the following integral monitoring options:
 - a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - 1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
 - 2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - 3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

- b. Remote Status Monitor - The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
 - c. Audible Alarm and Silence Button - The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
 - d. Surge Counter - The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - 1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. A backup battery may also be utilized in order to achieve this functionality.
6. Overcurrent Protection - The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design - All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules may be ganged together in order to achieve higher surge current ratings.
8. Safety Requirements:
- a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. Replaceable modules are acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
 - b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.3 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity - The minimum surge current capacity the device is capable of withstanding (based on ANSI/IEEE C62.41 location category) shall be as follows:

1. Category C (Service Entrance Locations - Switchboards):
 - a. Per Phase - 240 kA
 - b. Per Mode - 120 kA
 2. Category B (High Exposure Rooftop Locations and Distribution Panelboards):
 - a. Per Phase - 160 kA
 - b. Per Mode - 80 kA
 3. Category A (Branch Locations - Panelboards):
 - a. Per Phase - 120 kA
 - b. Per Mode - 60 kA
- C. SPD Type - all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.4 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
 4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
 5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
 6. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly): Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

2.5 SWITCHGEAR / SWITCHBOARD, MCC, AND BUSWAY REQUIREMENTS

- A. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
1. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
 2. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be

made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

3. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
4. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.6 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
 1. NEMA 1 - Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
 2. NEMA 4 - Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only).
 3. NEMA 4X - Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Surface or Flush Mounted Panelboards with Exterior SPDs: Mount SPDs on the side or bottom of the panelboard, closest to the serving breaker. Make leads as short and straight as possible.
- C. Provide multi-pole, 30 Amp breaker as a dedicated disconnect for SPD unless otherwise indicated on drawings. Provide breakers for ALL SPDs.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control testing:
 1. After installing the Surge Protection Device, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete start-up checks and voltage verifications according to manufacturer's written instructions.
 3. Perform visual and mechanical inspection on each unit. Certify that units are installed per manufacturer's recommendations.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION 26 2417

SECTION 26 2701 - ELECTRICAL UTILITY SERVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Service Requirements
- B. Service Voltage Verification

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. System Characteristics: 480Y/277 volts, three phase, four-wire, 60 Hertz.

1.5 SUBMITTALS

- A. See section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Service Voltage Verification: The Contractor shall provide a letter verifying the availability of indicated voltage from the serving utility company. The letter shall be included in the submittal data. No electrical equipment shall be released for fabrication until such verification has been made.
- C. Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with utility company written requirements and NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 COORDINATION

- A. Services: Secondary service raceway and conductors by contractor. Transformer and primary service shall be provided by the Utility Company. The Contractor shall provide the transformer pad, underground raceway, and conductors to transformer as shown.

PART 2 PRODUCTS

2.1 COMPONENTS

- A. Meter Base: Furnished by utility company.

PART 3 EXECUTION

3.1 PREPARATION

- A. Arrange with utility company to obtain permanent electric service to the Project.
- B. Verify that field measurements are as indicated on utility company drawings.

3.2 INSTALLATION

- A. Install transformer pad as required by utility company.
- B. Contractor is responsible for all items required for the transformer pad including any additional conduits for metering and/or interpad conduit bank connections.
- C. Contractor shall provide underground raceway and conductors to transformer as shown.
- D. Maintain one copy of each document on site.
- E. Contractor shall seal all service entrance conduits to prevent water entry. Seal conduits at the pad mount transformers and inside the switchboard/switchgear.
- F. Conduit stub-ups inside primary and secondary compartments of padmount transformers shall be extended minimum 6-inches above pad.

END OF SECTION 26 2701

SECTION 26 2717 - EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 0534 - Conduit.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 0537 - Boxes.
- D. Section 26 2726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. General: No roughing shall be done until roughing drawings and exact electrical demand of equipment is obtained. Notify Design Professional of any discrepancies.
 - 1. Mechanical:
 - a. Review tabulated sheet of Power Wiring Requirements of all Mechanical Equipment specified in Division 23 of Specifications. Conduit, conductor, and breaker sizes shown for mechanical equipment are based upon the best available information on the equipment specified. The Contractor shall be

allowed to provide electrical circuits compatible with the proposed mechanical equipment where the mechanical equipment conforms to Division 23 of the specifications, but does not conform to the electrical criteria of these contract documents. The Contractor shall submit the proposed electrical modifications to the Design Professional for review prior to roughing. No additional costs to the contract will be allowed for these modifications.

- b. Provide 4" thick concrete housekeeping pad beneath any equipment free standing on concrete floor. Pad shall extend 2" on all sides of equipment and shall be beveled 1 inch on all sides.
- c. Provide conduit, wiring, boxes, adaptors for equipment terminations and disconnect switches. Provide power wiring through primary control device.
- d. Starters, push-button stations, contactors, relays, limit and safety devices, and control items are specified in DIVISION 23 except as shown in Motor Control Center. Unless otherwise noted, all starters shall be mounted between 24" and 80" above finished floor. Push-button stations shall be mounted at switch height except as noted.
- e. Laboratory equipment Make electrical connections to all equipment provided under this contract from outlets shown. Obtain roughing drawings prior to installing any outlets. Notify Architect of any discrepancies between roughing drawings and contract documents. The Contractor shall be allowed to provide electrical circuits compatible with kitchen equipment acceptable to the Architect but not conforming to electrical criteria of these contract documents, but the Contractor shall submit proposed electrical modifications to the Architect prior to roughing. No additional costs to the contract will be allowed for these changes.
- f. Owner Furnished Equipment: Provide conduit, wiring, boxes, adaptors for equipment terminations, and disconnect switches. Make all connections indicated.

E. Sequence electrical connections to coordinate with start-up of equipment.

F. The intent is to provide SO cord connection, through a plug and receptacle provided by the contractor, to any kitchen equipment listed as "direct connect" on the kitchen equipment schedule. This will serve as the disconnecting means in most cases, without the need of additional, separate box-type disconnects. Pay close attention to the FLA ratings of kitchen devices and provide cord, plug, and receptacle rated for that current.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Wiring Devices: As specified in Section 26 2726.

- C. Flexible Conduit: As specified in Section 26 0534.
- D. Wire and Cable: As specified in Section 26 0519.
- E. Boxes: As specified in Section 26 0537.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements. Pay close attention to the requirements of DCU's and DAC's. The electrical contractor is responsible for interconnecting the wiring between these two pieces.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings. Plug all raceway penetrating freezer/cooler wall with white permagum to prevent moisture condensation.

END OF SECTION 26 2717

SECTION 26 2726 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.
- D. Floor box service fittings.
- E. Poke-through assemblies.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 4. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
 - 5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.3 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

PART 2 PRODUCTS

2.1 GENERAL:

- A. Different type devices shall match in color. Receptacles, light switches, low voltage switches, wall mounted occupancy sensors, etc. shall be the same color with the same type of trim or cover. Provide submittals data indicating this color prior to purchasing.

2.2 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
- D. Provide tamper resistant receptacles for all receptacles installed in dwelling units.
- E. Provide GFI protection for all receptacles installed within 6 feet of sinks.
- F. Provide GFI protection for all receptacles installed in kitchens.
- G. Provide GFI protection for all receptacles serving electric drinking fountains.
- H. Unless noted otherwise, do not use combination switch/receptacle devices.

2.3 WIRING DEVICE FINISHES:

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: Ivory with stainless steel wall plate.
- C. Wiring Devices Installed in Wet or Damp Locations: Ivory with specified weatherproof cover.
- D. Wiring Devices Connected to Emergency Power: Red with stainless steel wall plate.

2.4 WALL SWITCHES

- A. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

- B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- C. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- D. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- E. Switch Types: Single pole, double pole, 3-way, 4-way, pilot gang, and key.
 - 1. Single Pole Switches:
 - a. Cooper 2221
 - b. Hubbell HBL1221
 - c. Leviton 1221-2
 - d. P&S PS20AC1
 - 2. Double Pole Switches:
 - a. Cooper 2222
 - b. Hubbell HBL1222
 - c. Leviton 1222-2
 - d. P&S PS20AC2
 - 3. 3-Way Switches:
 - a. Cooper 2223
 - b. Hubbell HBL1223
 - c. Leviton 1223-2
 - d. P&S PS20AC3
 - 4. 4-Way Switches:
 - a. Cooper 2224
 - b. Hubbell HBL1224
 - c. Leviton 1224-2
 - d. P&S PS20AC4
 - 5. Pilot Gang (provide for lighting control of all Janitor's closets, closets, and storage spaces where the switch is located outside the space):
 - a. Cooper 2221PL
 - b. Hubbell HBL1221PL
 - c. Leviton 1221-PL
 - d. P&S PS20AC1-RPL7
 - 6. Key:
 - a. Cooper 2221L
 - b. Hubbell HBL1221L
 - c. Leviton 1221-2L
 - d. P&S PS20AC1-L

2.5 RECEPTACLES

- A. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.

- B. Convenience Receptacles:
 - 1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 - 2. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
 - 3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, , listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 - 4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, , listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 - 5. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, , listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

- C. GFI Receptacles:
 - 1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.
 - 2. Standard GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 - 3. Weather Resistant GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
 - 4. Tamper Resistant GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
 - 5. Tamper Resistant and Weather Resistant GFI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

- D. Outlet Types:
 - 1. Duplex Convenience Receptacles.
 - a. Cooper 5362
 - b. Hubbell HBL5362
 - c. Leviton 5362

- d. P&S 5362-A
- 2. GFCI Receptacles (Hospital Use): Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Devices shall be UL943 Compliant.
 - a. Cooper XHGF20
 - b. Hubbell GF8300
 - c. Leviton 8898-HG
 - d. P&S 2094-HG
- 3. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Devices shall be UL943 Compliant.
 - a. Cooper XGF20
 - b. Hubbell GF5362
 - c. Leviton 8898
 - d. P&S 2095
- 4. Hospital Use Receptacles:
 - a. Cooper 8300
 - b. Hubbell HBL8300
 - c. Leviton 8300
 - d. P&S 8300
- 5. Safety Receptacles:
 - a. Cooper TR8300
 - b. Hubbell HBL8300SG
 - c. Leviton 8300SG
 - d. P&S TR63H
- 6. Isolated Ground Receptacles:
 - a. Cooper IG5362
 - b. Hubbell IG5362
 - c. Leviton 5362-IG
 - d. P&S IG6300

2.6 WALL PLATES

- A. All Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- C. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.7 FLOOR BOX SERVICE FITTINGS

- A. Description: Service fittings compatible with floor boxes provided under Section 26 0537 with all components, adapters, and trims required for complete installation. Note:

floorboxes must be flush with the floor, with less than 1/4" trim above the surrounding floor material. Anything greater than 1/4" shall be reworked to make flush. See plans for floorbox types.

2.8 POKE-THROUGH ASSEMBLIES

- A. See plans for poke-thru type basis of design.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of wiring devices provided under this section.
- B. Install wiring devices in accordance with manufacturer's instructions.
- C. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- D. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

- E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- G. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- H. Provide GFI receptacles with integral GFI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- I. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- J. Install in accordance with NECA "Standard of Installation."
- K. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- L. Install wall switches with OFF position down.
- M. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- N. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- O. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- P. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- Q. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- R. Install poke-through closure plugs in all unused core holes to maintain fire rating of floor.
- S. Install receptacles with grounding pole on bottom.
- T. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- U. Install wall plates on switch, receptacle, and blank outlets.
- V. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- W. Connect wiring devices by wrapping conductor around screw terminal.
- X. Use jumbo size plates for outlets installed in masonry walls.

- Y. Install plates with all edges in contact with the finished wall.
- Z. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- AA. Mount all plates vertically unless otherwise noted.
- AB. Where two or more devices are shown adjacent, they shall be mounted in ganged boxes and covered with one faceplate.
- AC. Install protective rings on active flush cover service fittings.
- AD. Where outlets of different levels are shown adjacent, they shall be installed in one vertical line. Outlets shown back to back on a common wall shall be offset a minimum of 10 inches to dampen sound transmission through the wall.
- AE. On all walls with 1 hour or greater fire rating, "back to back" outlets shall be installed a minimum of 24 inches apart. Mount with stud between outlets for gypboard constructed partitions.
- AF. Where outlets are installed in unfinished block or tile partitions they shall be installed at the points in the tile to permit the face plate to cover the rough opening. The horizontal and vertical locations indicated may be altered to permit above installation. Contractor shall check the Architectural drawings to prevent conflicts when shifting locations.
- AG. Provide GFI receptacles where located within 6' of a water source, and as shown on plans.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 0537 to obtain mounting heights specified.
- B. Where outlets are shown above cabinets or casework, install outlet 6 inches above backsplash of counter.
- C. Where the mounting height of an outlet is not shown on the plans or specifications, the contractor shall contact the Architect for exact mounting height requirements.

3.5 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- C. Operate each wall switch with circuit energized and verify proper operation.
- D. Verify that each receptacle device is energized.
- E. Test each receptacle device for proper polarity prior to final inspection.

- F. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.6 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 26 2726

SECTION 26 2813 – FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 MAINTENANCE MATERIALS

- A. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- 2.2 Manufacturers: Bussman, G.E., Ferraz Shawmut, Economy, Cefco, Cutler Hammer.

2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.

- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Use only fuses of voltage, amperage and class compatible with fuse holder or disconnect.
- F. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- G. Voltage: Rating suitable for circuit phase-to-phase voltage.
- H. Main Service Switches Larger than 600 amperes: Class L (time delay).
- I. Disconnect Switches: 208 or 240V system U.L. Class RK-5, 250 volt rating with minimum interrupting capacity of 200,000 symmetrical amperes.
- J. Disconnect Switches: 277/480V or 600V systems U.L. Class RK-5, 600 volt rating with minimum interrupting capacity of 200,000 symmetrical amperes.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Provide fuses in all fused devices. This shall include equipment of other trades.
- C. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 26 2813

SECTION 26 2817 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0574 - Electrical Testing.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- E. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- F. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- G. UL 943 - Ground-Fault Circuit-Interruption; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Perform Work in accordance with NECA Standard of Installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D (basis of design).
- B. ABB/GE.
- C. Eaton.
- D. Siemens.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Short Circuit Current Rating:
- D. Conductor Terminations: Suitable for use with the conductors to be installed.
- E. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- F. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
- G. Provide externally operable handle with means for locking in the OFF position.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
 - 1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
- E. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- F. Provide the following circuit breaker types where indicated:
 - 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
- G. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
- H. Circuit Breakers: NEMA AB 1.
 - 1. Enclosure shall be NEMA 1 rated for indoor applications and NEMA 3R where exposed to weather.
 - 2. Provide with non-teasible, positive, quick-make, quick-break mechanisms.
 - 3. Minimum interrupting capacity (UL and NEMA) shall match that of the next panelboard upstream.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- C. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 26 0529.
- D. Install enclosed circuit breakers plumb.
- E. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- F. Provide grounding and bonding in accordance with Section 26 0526.

- G. Maximum mounting height to operating handle shall be 6 feet (1.9 M).
- H. Provide arc flash warning labels in accordance with NFPA 70.

3.2 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.3 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 26 2817

SECTION 26 2818 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fusible switches.
- B. Nonfusible switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0574 - Electrical Testing.
- D. Section 26 2813 - Fuses.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D (basis of design).
- B. ABB/GE.

- C. Eaton.
- D. Siemens.

2.2 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch (H.P. Rated).
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle and switching mechanism integral with switch base, with easily recognizable position and lockable in OFF position.
 - 3. Visible blades.
 - 4. Non-teasible, positive, quick-make, quick-break mechanism.
 - 5. Line terminal shields.
 - 6. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch (H.P. Rated).
 - 1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 - 2. Handle and switching mechanism integral with switch base, with easily recognizable position and lockable in OFF position.
 - 3. Visible blades.
 - 4. Non-teasible, positive, quick-make, quick-break mechanism.
 - 5. Line terminal shields.
- C. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior locations: Type 3R

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.
- I. Provide arc flash warning labels in accordance with NFPA 70.
- J. Install fuses in fusible disconnect switches.
- K. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

END OF SECTION 26 2818

SECTION 26 3213 - ENGINE GENERATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Packaged engine generator system and associated components and accessories:
 - 1. Engine and engine accessory equipment.
 - 2. Alternator (generator).
 - 3. Generator set control system.
 - 4. Generator set enclosure.

1.2 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 23 1123 - Facility Natural-Gas Piping.
- C. Section 23 5100 - Breechings, Chimneys, and Stacks: Engine exhaust piping.
- D. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- E. Section 26 0529 - Hangers and Supports for Electrical Systems.
- F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 3600 - Transfer Switches: Automatic transfer switch.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2018.
- C. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.
- D. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association, 2018 with all Georgia State modifications.
- E. NFPA 110 - Standard for Emergency and Standby Power Systems; 2016.
- F. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
- G. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Manufacturer's factory emissions certification.
- B. Manufacturer's detailed field testing procedures.
- C. Maintenance contracts.
- D. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- E. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
- F. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, and remote radiator.
- G. Test Reports: Indicate results of performance testing.
- H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- I. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- J. Manufacturer's Field Reports: Indicate procedures and findings.
- K. Operation Data: Include instructions for normal operation.
- L. Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures. Include parts list.

1.5 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70 (National Electrical Code).
 - 2. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL).
- C. Conform to requirements of NFPA 70.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.

- E. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- F. Products: Furnish products listed and classified by Underwriters Laboratories as suitable for purpose specified and indicated.
- G. This system shall be built, tested, shipped, installed, site load bank tested, and started by one source of supply and responsibility. After start-up and testing, before final inspection, the contractor shall provide the supplier's system certificate to the Owner, with test results.
- H. The performance of this generating set shall be certified by an independent testing laboratory as to the sets full power rating, stability and voltage and frequency regulation.
- I. For all new natural gas units, the genset shall be factory certified to the current spark ignited NSPS (new source performance standard). In the event factory certification is not an option, the supplier shall confirm and/or provide relevant documentation which shows the genset is capable of achieving field certification. The supplier shall also submit budgetary cost guidance for field certification or provide references of companies capable of providing field certification. If necessary, the supplier shall specifically identify and supply any emissions reduction technology (catalysts) necessary for their genset to meet certification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to generator set components, enclosure, and finish.

1.7 MAINTENANCE SERVICE

- A. Furnish service and maintenance of engine generator for one year from Date of Material Completion.
- B. Service contract shall include one semi-annual inspection and one annual preventive maintenance that includes changing oil, all filters, and 4 hour loadbank test one year after initial startup

1.8 WARRANTY

- A. This standby electric power system, furnished completely by the manufacturer, shall be warranted for a period of five years from the date of system acceptance.

- B. The warranty shall be comprehensive and include travel, parts, labor, and generator rental on a warranty generator failure.

1.9 MAINTENANCE MATERIALS

- A. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box.

1.10 EXTRA MATERIALS

- A. Provide two of each fuel, oil and air filter element.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Generac (basis of design).
- B. Caterpillar.
- C. Cummins.
- D. MTU.
- E. Kohler.

2.2 PACKAGED ENGINE GENERATOR SYSTEM

- A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. System Description:
 - 1. Application: Emergency/standby.
 - 2. Configuration: Single packaged engine generator set operated independently (not in parallel).
- D. Packaged Engine Generator Set:
 - 1. Type: Gaseous (spark ignition).
 - 2. Power Rating: 125 kW, standby.
 - 3. Voltage: 480Y/277 V, 3 phase, 60 Hz.
- E. Generator Set General Requirements:
 - 1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
 - 2. Factory-assembled, with components mounted on suitable base.
 - 3. List and label engine generator assembly as complying with UL 2200.

4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
 5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
- F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
- G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.
 2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
 3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
 4. Maximum Load Step: Supports 100 percent of rated load in one step.
- H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
 2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

- A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.
- B. Engine Fuel System - Gaseous (Spark Ignition):
1. Fuel Source: Natural gas.
 2. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
 3. Provide components/features indicated and as necessary for operation and/or required by applicable codes, including but not limited to:
 - a. Carburetor.
 - b. Gas pressure regulators.
 - c. Fuel shutoff control valves.
 - d. Low gas pressure switches.
- C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
 2. Battery(s):
 - a. Battery Type: Lead-acid.
 - b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

- c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
 3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
 4. Battery Charger:
 - a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
 - b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
 - c. Recognized as complying with UL 1236.
 - d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
 - e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
 - f. Provide alarm output contacts as necessary for alarm indications.
- D. Engine Speed Control System (Governor):
 1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
 2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.
- E. Engine Lubrication System:
 1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
- F. Engine Cooling System:
 1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
 2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
 3. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.
- G. Engine Air Intake and Exhaust System:
 1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
 2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.4 ALTERNATOR (GENERATOR)

- A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

- B. Exciter:
 - 1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
 - 2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
 - 3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.
- C. Temperature Rise: Comply with UL 2200.
- D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
- E. Enclosure: NEMA MG 1, drip-proof.
- F. Total Harmonic Distortion: Not greater than five percent.

2.5 GENERATOR SET CONTROL SYSTEM

- A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
- B. Control Panel:
 - 1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
 - 2. Generator Set Control Functions:
 - a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
 - b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
 - c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
 - d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
 - e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
 - f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
 - g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
 - 3. Generator Set Status Indications:
 - a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
 - b. Current (Amps): For each phase.
 - c. Frequency (Hz).
 - d. Real power (W/kW).
 - e. Reactive power (VAR/kVAR).
 - f. Apparent power (VA/kVA).
 - g. Power factor.
 - h. Duty Level: Actual load as percentage of rated power.
 - i. Engine speed (RPM).
 - j. Battery voltage (Volts DC).
 - k. Engine oil pressure.

- l. Engine coolant temperature.
- m. Engine run time.
- n. Generator powering load (position signal from transfer switch).
- 4. Generator Set Protection and Warning/Shutdown Indications:
 - a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).
 - 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
 - b. In addition to NFPA 110 requirements, provide the following protections/indications:
 - 1) High AC voltage (shutdown).
 - 2) Low AC voltage (shutdown).
 - 3) High frequency (shutdown).
 - 4) Low frequency (shutdown).
 - 5) Overcurrent (shutdown).
 - c. Provide contacts for local and remote common alarm.
 - d. Provide lamp test function that illuminates all indicator lamps.
- 5. Other Control Panel Features:
 - a. Event log.

C. Remote Annunciator:

- 1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
- 2. Generator Set Status Indications:
 - a. Generator powering load (via position signal from transfer switch).
 - b. Communication functional.
- 3. Generator Set Warning/Shutdown Indications:
 - a. Comply with NFPA 110 for Level 1 systems including but not limited to the following indications:
 - 1) Overcrank (shutdown).
 - 2) Low coolant temperature (warning).
 - 3) High coolant temperature (warning).
 - 4) High coolant temperature (shutdown).
 - 5) Low oil pressure (shutdown).
 - 6) Overspeed (shutdown).
 - 7) Low fuel level (warning).

- 8) Low coolant level (warning/shutdown).
 - 9) Generator control not in automatic mode (warning).
 - 10) High battery voltage (warning).
 - 11) Low cranking voltage (warning).
 - 12) Low battery voltage (warning).
 - 13) Battery charger failure (warning).
- b. Provide audible alarm with silence function.
 - c. Provide lamp test function that illuminates all indicator lamps.
- D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.6 GENERATOR SET ENCLOSURE

- A. Enclosure Type: Sound attenuating, weather protective. Provide a Level II sound attenuated enclosure, with max 71 dBA at 7 meters.
- B. Enclosure Material: Steel or aluminum.
- C. Hardware Material: Stainless steel.
- D. Color: Manufacturer's standard.
- E. Access Doors: Lockable, with all locks keyed alike.
- F. Openings: Designed to prevent bird/rodent entry.
- G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
- H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
- I. Utilize an upward discharging radiator hood.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive equipment.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install products in accordance with manufacturer's instructions.
- C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
- D. Arrange equipment to provide minimum clearances and required maintenance access.
- E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 03 3000. Provide suitable vibration isolators, where not factory installed.
- F. Provide required support and attachment in accordance with Section 26 0529.
- G. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
- H. Provide natural gas piping in accordance with Section 23 1123.
- I. Provide engine exhaust piping in accordance with Section 23 5100, where not factory installed.
 - 1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
 - 2. Do not exceed manufacturer's maximum back pressure requirements.
- J. Provide grounding and bonding in accordance with Section 26 0526.
- K. Identify system wiring and components in accordance with Section 26 0553.
- L. Provide an 8-inch thick concrete pad with #3 rebar 6-inches on center. Pad shall extend 6-inches on all sides of generator unit.

3.3 FIELD QUALITY CONTROL

- A. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- B. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
- C. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- D. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
- E. Preliminary inspection and testing to include, at a minimum:
 - 1. Inspect each system component for damage and defects.

2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
 3. Check for proper oil and coolant levels.
- F. Prepare and start system in accordance with manufacturer's instructions.
- G. Provide field emissions testing where necessary for certification.
- H. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.4 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of four hours of training.
 3. Instructor: Manufacturer's authorized representative.
 4. Location: At project site.

3.6 PROTECTION

- A. Protect installed engine generator system from subsequent construction operations.

3.7 MAINTENANCE

- A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.
- B. Provide trouble call-back service upon notification by Owner:
1. Provide on-site response within 4 hours of notification.
 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

- C. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 26 3213

SECTION 26 3600 - TRANSFER SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
 - 1. Automatic transfer switches.
- B. Automatic Transfer Switch.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0574 - Electrical Testing.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 3213 - Engine Generators: Testing requirements.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.
- D. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
 - 2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Coordinate the work with placement of supports, anchors, etc. required for mounting.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Maintenance contracts.
- B. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- C. Product Data: Provide catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation Data: Instructions for operating equipment under emergency conditions when engine generator is running.
- F. Maintenance Data: Routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.6 QUALITY ASSURANCE

- A. Comply with the following:
 1. NFPA 70 (National Electrical Code).
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL).
- C. Conform to requirements of NFPA 70.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- E. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
- F. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's instructions to avoid damage to transfer switch components, enclosure, and finish.

1.8 MAINTENANCE SERVICE

- A. Provide service and maintenance of transfer switches for one year from Date of Material Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ASCO
- B. Russelectric
- C. Zenith

2.2 TRANSFER SWITCHES

- A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Construction Type: Either "contactor type" (open contact) or "breaker type" (enclosed contact) transfer switches complying with specified requirements are acceptable.
- D. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).
- E. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.
- F. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.
- G. Switching Methods:
 - 1. Obtain control power for transfer operation from line side of source to which the load is to be transferred.
- H. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

- I. Enclosures:
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Finish: Manufacturer's standard unless otherwise indicated.
- J. Short Circuit Current Rating:

2.3 AUTOMATIC TRANSFER SWITCH

- A. Description: NEMA ICS 10, automatic transfer switch suitable for use as service equipment.
- B. Configuration: Electrically operated, mechanically held transfer switch.
- C. Withstand Current Rating: Match that of normal power main switchboard/switchgear.
- D. Interrupting Capacity: 100 percent of continuous rating.
- E. Withstand Current Rating: 65,000 rms symmetrical amperes, when used with Class J current limiting fuse.

2.4 COMPONENTS

- A. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE.
- B. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
- C. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
- D. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.
- E. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
- F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
- G. Switched Neutral: Overlapping contacts.
- H. Enclosure: ICS 10, Type 1, finished with manufacturer's standard gray enamel.

2.5 AUTOMATIC SEQUENCE OF OPERATION

- A. Upon loss of normal power, the engine shall start, come up to speed/voltage and the load associated with ATS-LS shall be transferred to the emergency source within 10 seconds. ATS-EQ shall be delayed from transfer for 30 seconds after the generator has stabilized.
- B. The generator output shall be continuously monitored. When the generator output reaches 90% capacity the following shall occur:
 - 1. ATS-EQ shall transfer back to the normal source.
 - 2. An alarm shall be initiated on the generator annunciator panel (visual and audible).
- C. In the event of any generator malfunction which would impair the capacity of the generator to deliver 100% of its rated capacity (eg. oil pressure, engine temperature, etc. - to be recommended by the generator manufacturer), ATS-EQ shall be transferred to normal power to unload the generator. ATS-LS shall remain connected to the generator. These loads constitute life safety requirements.
- D. Provide a signal to elevator controls 20 seconds before transfer of power from emergency to normal power.
- E. Upon power line return, transfer the load back to the line and stop the standby set.
- F. Total time from start-up until shutdown shall be adjustable, set for 20 minutes.
- G. The transfer switch shall not transfer from emergency to normal source until the normal source has been restored for 15 minutes unless the emergency source is lost.
- H. Automatic load transfer control to provide automatic starting and stopping of the engine and switching of the load.
- I. The load transfer control shall be rated for continuous duty and for all classes of load.
- J. The ampere rating of the transfer switch shall be of minimum size to handle the generator output or shall be of minimum size shown on the drawings, whichever is larger.
- K. The control components shall be compatible with the electrical requirements of the generator set.
- L. Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.
- M. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.

- C. Verify that rough-ins for field connections are in the proper locations.
- D. Verify that mounting surfaces are ready to receive transfer switches.
- E. Verify that conditions are satisfactory for installation prior to starting work.
- F. Provide housekeeping pads under the provisions of Section 03 3000.

3.2 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install transfer switches in accordance with manufacturer's instructions.
- C. Arrange equipment to provide minimum clearances and required maintenance access.
- D. Provide required support and attachment in accordance with Section 26 0529.
- E. Install transfer switches plumb and level.
- F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Identify transfer switches and associated system wiring in accordance with Section 26 0553.
- I. Provide engraved plastic nameplates under the provisions of Section 26 0553.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide the services of the manufacturer's technical representative to check out transfer switch connections and operations and place in service.

3.4 CLOSEOUT ACTIVITIES

- A. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.

3.5 PROTECTION

- A. Protect installed transfer switches from subsequent construction operations.

3.6 MAINTENANCE

- A. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of

Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

- B. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- C. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION 26 3600

SECTION 26 4113 - LIGHTNING PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air terminals and interconnecting conductors.
- B. Grounding and bonding for lightning protection.

1.2 RELATED SECTIONS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems

1.3 REFERENCES

- A. NFPA 780 - Standard for the Installation of Lightning Protection Systems; National Fire Protection Association; 2004.
- B. UL 96 - Lightning Protection Components; Underwriters Laboratories Inc.; 2005.
- C. UL 96A - Installation Requirements for Lightning Protection Systems; Underwriters Laboratories Inc.; Twelfth Edition.
- D. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. Lightning Protection System: Conductor system consisting of air terminals on roofs; bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
- C. Product Data: Provide dimensions and materials of each component, and include indication of testing agency listing.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

- E. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 780 and UL 96A and provide UL Certified System.
- B. Maintain one copy of each document on site.
- C. Products: Furnish products listed and classified by testing agency as complying with UL 96.
- D. Manufacturer Qualifications: Company specializing in lightning protection equipment with minimum three years documented experience .
- E. Installer Qualifications: Authorized installer of manufacturer with minimum three years documented experience .

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Lightning Protection:
 - 1. Harger Lightning and Grounding.
 - 2. East Coast Lightning Equipment (ECLE).
 - 3. Thompson Lightning Protection, Inc.
 - 4. Robbins Lightning, Inc.
 - 5. Heary.

2.2 COMPONENTS

- A. Air Terminals: Copper, solid.
 - 1. Terminals shall not be less than 15 inches in height.
 - 2. The terminal shall taper to a point.
 - 3. The terminal below the taper shall be 1/2 inches in diameter.
 - 4. Terminals more than 18 inches in height shall be supported by a brace, with guides, not less than one-half the height of the air terminal.
- B. Grounding Rods: Solid copper.
 - 1. Diameter: Minimum 5/8 inches.
 - 2. Length: Minimum 10 feet.
- C. Conductors: Copper cable, of weight and size necessary to achieve system certification. Aluminum conductors may be utilized as necessary to prevent dissimilar metals interaction.
- D. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated on shop drawings.
- B. Coordinate work with roofing and exterior and interior finish installations.

3.2 INSTALLATION

- A. Install in accordance with NFPA 780 and UL 96A.
- B. Connect conductors using mechanical connectors. Protect adjacent construction elements and finishes from damage.
- C. Bond exterior metal bodies on building to lightning protection system .
- D. Integral System on Steel Frame:
 - 1. The steel framework or reinforcement shall be made electrically continuous.
 - 2. Electrical continuity may be provided by bolting, riveting, or welding steel frame and by tying, clipping, or welding reinforcing bars.
 - 3. The air terminals shall be securely attached to the structural steel frame. Air terminals placed on top of parapet walls shall be secured using adhesive rated for this purpose.
 - 4. Short runs of conductors may be necessary to join air terminals to the metal framework so that proper placing of air terminals is maintained.
 - 5. Separate down conductors from air terminals to ground connections are not required.
 - 6. Where a water system enters the building, the structural steel or reinforcing framework and the water system shall be securely connected at the point of entrance by a ground conductor.
 - 7. Connections to pipes and reinforcing bars shall be by means of substantial ground clamps with lugs.
 - 8. Connections to structural framework shall be by means of nut and bolt or welding.
 - 9. All connections between columns and ground connections shall be made at the bottom of the columns.
- E. Provide down conductors as required.
- F. Spacing between down conductors shall not exceed 60 feet.
- G. Down conductors shall be routed concealed in partitions, chases, or furring around columns.
- H. In each perimeter cast-in-place concrete column, provide a 1" PVC conduit continuous from the column top to below grade, for down conductor installation.

3.3 FIELD QUALITY CONTROL

- A. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and certification of the lightning protection system.
- B. Provide copy of the UL Master Label Certificate (MLC).

END OF SECTION 26 4113

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires.
- B. Exit signs.
- C. Ballasts and drivers.

1.2 RELATED REQUIREMENTS

- A. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- B. Section 26 5600 - Exterior Lighting.

1.3 REFERENCE STANDARDS

- A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.
- B. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
- F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- J. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.

- K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 DESIGN INTENT

- A. See plans.
- B. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
- C. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
- D. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
- E. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
- C. Product Data: Provide as specified.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting) and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.7 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.8 WARRANTY

- A. Provide three year manufacturer warranty for all LED luminaires, including drivers.
- B. Provide five year warranty for batteries for emergency lighting units.
- C. Provide five year warranty for batteries for self-powered exit signs.
- D. Provide five year warranty for fluorescent emergency power supply units.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

- A. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- B. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- C. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- D. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
 - 4. Air-Handling Recessed Fluorescent Luminaires: Suitable for air supply/return, heat removal, or combination as indicated.
- E. LED Luminaire Components: UL 8750 recognized or listed as applicable.
- F. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.
- G. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

- H. The Contractor shall verify all voltages to fixtures and shall furnish fixtures, ballasts, etc. compatible with voltages from panels serving fixtures.

2.3 EXIT SIGNS

- A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.
- B. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single or double as indicated or as required for the installed location.
 - 2. Directional Arrows: As indicated or as required for the installed location.

2.4 LED DRIVERS

- A. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.
 - a. Wall Dimmers: See Section 26 2726.
 - b. Daylighting Controls: See Section 26 0923.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- D. Suspended Ceiling Mounted Luminaires or Track:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Secure surface-mounted, recessed, and pendant-mounted luminaires to building structure.
 - 3. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 4. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 18 gauge, connected from diagonal corners of each recessed luminaire to building structure.
 - 5. For all track pieces, provide no more than 10' between supports to structure.
- E. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Stems shall not be less than 8-inches in length.
 - 4. Fixtures shall be supported from structure.
 - 5. Provide minimum of two supports for each luminaire, with no more than 4 feet between supports.
 - 6. Install canopies tight to mounting surface.
 - 7. Unless otherwise indicated, support pendants from swivel hangers.
 - 8. No fixture shall be suspended using chain, unless specifically indicated on the plans.
- F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
- G. Install accessories furnished with each luminaire.
- H. Bond products and metal accessories to branch circuit equipment grounding conductor.
- I. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- J. Identify luminaires connected to emergency power system in accordance with Section 26 0553.
- K. Locating Light Fixtures in Mechanical Equipment Spaces: The Contractor shall adjust fixture locations to avoid conflicts with ducts, piping, and equipment. Locate fixtures

below and clear of ducts, pipes, and equipment. Fixtures shall not conflict with required access to duct, piping, and equipment, including but not limited to valves, instruments, and access doors. The Contractor shall relocate fixtures deemed to have conflicts at the discretion of the Design Professional.

- L. Wall mounted exit signs shown over doors:
 - 1. Atriums, lobbies or corridors with high ceilings, storefront: Confirm location and mounting height with A/E prior to rough-in of these areas.
 - 2. Other locations:
 - a. If the ceiling is 12' or lower, locate the exit sign centered between the top of the door frame and the ceiling. All exit signs mounted over doors in the same space shall be at the same height.
 - b. If the ceiling is greater than 12', mount the exit sign such that the bottom of the sign is 7'-6" above finished floor.
- M. For ceiling hung exit signs, hang via threaded rod down to the same level as the track lighting in the space. Rod shall be painted.
- N. Any luminaire larger than 2' x 4' shall be supported independent of ceiling framing.
- O. The Contractor shall verify all ceiling types and configuration prior to ordering fixtures. The Contractor shall review the reflected ceiling plan, including any changes or modifications to the documents made during construction. The Contractor shall furnish fixtures compatible with the ceiling type being installed.
- P. Locate recessed ceiling luminaires as indicated on the reflected ceiling plan.
- Q. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- R. Install recessed luminaires to permit removal from below.
- S. Install wall mounted fixtures at height indicated. Request this information prior to rough-in if no height is indicated.
- T. Connect luminaires to branch circuit junction boxes provided under Section 26 0537 using flexible conduit. Support flexible conduit from structure. Flexible conduit shall not rest on ceiling tiles, and shall not rest on ceiling grid supports. Do not support flexible conduit from ceiling support wires. Do not support flex conduit from luminaire support wires.
- U. Structural system attachments, unless noted otherwise:
 - 1. Poured-in-place concrete or precast solid masonry: Concrete expandable anchors.
 - 2. Steel Bar Joists or Steel Beams: 1 5/8-inch x 3/4-inch x 12 gauge channel bolted to top chords. Drill channel and secure threaded rod to channel
 - 3. Along bar joist or steel beam center line: Malleable iron beam clamp.

3.4 FIELD QUALITY CONTROL

- A. See Division 1 for additional quality requirements.

- B. Inspect each product for damage and defects.
- C. Operate each fixture after installation and connection. Inspect for proper connection and operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting) and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosures.
- D. Clean photometric control surfaces as recommended by manufacturer.
- E. Clean finishes and touch up damage.
- F. Replace any cracked or bent lenses or louvers. Replace any lenses or louvers with deficiencies as noted by the Design Professional.

3.7 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- B. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 5100

SECTION 26 5200 - SENSOR LIGHTING CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Occupancy Sensors.
- B. Indoor Daylight Light Level Controllers.
- C. Outdoor Type Photoelectric Switches.

1.2 RELATED SECTIONS

- A. Section 26 5100 - Interior Lighting.
- B. Section 26 5600 - Exterior Lighting.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.

1.4 SYSTEM DESCRIPTION

- A. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
- B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.
- C. Where applicable, occupancy sensors shall be wired in a "Manual ON/ Auto OFF" configuration.
- D. Set the factory default to Auto OFF at 20 minutes.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide product data sheets for all equipment to be used. Provide circuit diagrams of each type of device. Circuit diagrams shall indicate type of control wire and/or line voltage wire used.

- C. Shop Drawings: Indicate layout of each interior space showing proper placement and aiming of occupancy sensor shown on the plans. Notify the Architect immediately of any possible conflicts with equipment / room layout shown on the plans. These drawings shall be produced using a CAD based program and submitted on full size (minimum "D" size) prints.
- D. Product data shall clearly indicate method used to handle inrush current for all wall switch products.
- E. Product data shall clearly state any load restrictions when used with electronic ballasts.
- F. Project Record Documents: Record actual locations of installed sensors and controls. Drawings shall include location of all power packs and low voltage wiring.

1.6 QUALITY ASSURANCE

- A. The Contractor shall schedule an onsite meeting with an authorized factory agent to instruct the Contractor in proper mounting, adjustments and aiming of the occupancy sensors. This meeting shall take place prior to start of sensor installation.
- B. Perform work in accordance with NFPA 70.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- D. All products shall be from the same manufacturer.
- E. All components shall be U.L. listed.
- F. Products shall be manufactured by an ISO 9002 certified manufacturing facility.
- G. Wall switch products shall be capable of withstanding the effects of inrush current.

1.7 WORK INCLUDED

- A. The Contractor shall provide all labor, materials, tools, appliances, control hardware, sensors, wiring, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as shown on the plans and as described herein.
- B. The Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, luminaires, HVAC systems and building management systems.

1.8 WARRANTY

- A. Provide five year manufacturer warranty for all components.

- B. Any equipment found to be damaged, defective or non-conforming shall be replaced at no additional cost to the owner.

1.9 EXTRA MATERIALS

- A. Supply two additional power packs and one additional sensor of each type used for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Occupancy Sensors:
 1. The WattStopper
 2. Mytech
 3. Leviton
 4. Hubbell
 5. Pass & Seymour
 6. Lutron
 7. Lightolier
 8. Novitas
 9. Lithonia
- B. Outdoor Type Photoelectric Switches:
 1. Paragon
 2. Tork
 3. Intermatic
 4. Precision
 5. Ripley

2.2 OCCUPANCY SENSORS

- A. NOTE: 360 degree sensors are typically shown in the center of the space on the plans. Where ceiling mounted sensors are shown in the corners of spaces, these sensors should not be 360 degree, rather they should be designed for corner-room operation. The contractor and manufacturer shall coordinate this requirement and shall not provide a single type sensor for all applications. The plans show the type (infrared, ultrasonic, or combination) only. The location in the space should provide guidance as to the exact product to be chosen. Where sensors are to be mounted in the ceiling above 15 ft, use high density lenses to maintain sensitivity.
- B. Note: Wall mounted occupancy sensors shall match line voltage switches in color. Provide decora style covers to match line voltage covers.
- C. Note: Ceiling mounted occupancy sensors shall be white.
- D. The passive infrared sensors shall be capable of detecting presence, in the control area, by detecting changes in the Infrared energy. Small movements shall be detected such as when a person is writing while seated at a desk.

- E. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- F. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
- G. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have a 180 degree coverage capability.
- H. Wall switch sensors shall include means of protecting the internal relay from the effects of inrush current.
- I. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
- J. If an open circuit occurs in the AC line (such as a ballast or lamp failure), the sensor shall automatically switch to OFF mode.
- K. In the event of a sensor failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain ON constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
- L. Wall switch sensor shall have 2 positions only, OFF and AUTO, for normal operation.
- M. Wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON. Manual ON shall be the default.
- N. Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.
- O. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up. The lens shall filter short wavelength IR such as those emitted by the sun and other visible light sources.
- P. Ultrasonic sensing shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and airflow throughout controlled space.
- Q. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.01% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
- R. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound will not be considered.
- S. For dual technology sensors, detection verification of BOTH technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on.

- T. Dual technology sensors shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
- U. All sensors used in the center of a space shall provide for 360 degrees of coverage.
- V. Sensors shall be capable of being wired in parallel to allow coverage of large areas.
- W. To avoid false ON activations and to provide high sensitivity to minor motion, Pulse Count Processing and Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
- X. Sensor shall incorporate field-selectable logic configurations which allows for space utilization changes and/or other special field conditions.
- Y. Where specified, passive infrared and dual technology sensors shall offer daylighting foot candle adjustment control and be able to accommodate dual level lighting.
- Z. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
- AA. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
- AB. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- AC. Power packs for sensors shall have an internal, additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

2.3 CIRCUIT CONTROL HARDWARE (POWER PACKS)

- A. Control units shall be capable of external mounting through a 1/2" knock-out on a standard electrical enclosure. Unit shall be rated for plenum installation.
- B. The control unit shall be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to power the sensor.
- C. Each control unit shall be capable of powering a minimum of two occupancy sensors.
- D. Relay contacts shall have ratings of:
 - 1. 13A - 120 VAC Tungsten
 - 2. 20A - 120 VAC Ballast
 - 3. 20A - 277 VAC Ballast
- E. Control wiring between sensors and control units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums.

- F. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

2.4 INDOOR DAYLIGHT LIGHT LEVEL CONTROLLER

- A. Provide indoor daylight light level controllers where shown and preset to footcandle level at 40-foot candles.
- B. The light level controller shall be capable of detecting changes in lighting levels. The light level controller shall utilize an internal photo conductive cell to measure light levels.
- C. The light level controller shall be capable of controlling any type of lighting. It shall be a self-contained device. Unit shall contain power supplies, contacts and all accoutrements to control one 20 ampere lighting circuit(s). Unit power shall be derived from the lighting branch circuit.
- D. The light level controller shall be capable of turning lighting on and off between 10 and 200 footcandles for low lighting levels and between 50 and 1000 footcandles for brighter areas.
- E. The light level controller shall have an adjustable deadband feature with a 1 to 3 ratio to prevent the cycling of lighting with minor lighting level changes.
- F. The light level controller shall have an adjustable time delay range of 3 seconds to 5 minutes minimum to prevent cycling on and off during momentary lighting changes.
- G. The light level controller shall have LED's to indicate the status of the sensor.
- H. Each sensor shall be furnished with a by-pass provision to enable override of the sensor in case of a failure. Sensor shall have a minimum 5 year warranty.

2.5 OUTDOOR TYPE PHOTOELECTRIC SWITCH

- A. Photoelectric switch shall be single pole, single throw, with hot/neutral/switched conductors. Switch shall be rated 20 amps. Switch shall be weatherproof, designed for temperature range of -30F to +140F.
- B. PE switch shall turn on at 1.5 footcandles and off at 10 footcandles. PE switch shall contain a 20 second time delay.
- C. PE switch shall fail with the switch closed.
- D. Mount the PE switch facing generally north, adjusted to avoid interaction with nearby artificial lighting. Nipple the PE switch to hole in cast fixture or box with double locknuts and double gaskets. Mount PE switch to a box hub with sealant. Provide a waterproof installation.
- E. Where PE switch is mounted on top of a building, provide a cast FS box with conduit hubs. Orient the box with side opening gasketed WP lid, with PE switch on top, and

homerun conduit out the bottom. Seal the conduit entries into the box. Duct-seal the homerun from inside the box.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Locate and aim sensors to provide complete and proper volumetric coverage within the manufacturer's specified range of coverage.
- C. Spaces shall have 90% - 100% coverage to completely cover the controlled area, accommodating all occupancy habits of single or multiple occupants at any location within the room(s).
- D. The location of sensors shown on the plans are diagrammatic only. Locate sensors to avoid interference with possible obstructions.
- E. Locate sensors a minimum of 6 feet from and HVAC supply diffuser or return grille.
- F. Provide all power/switch packs required to make the system fully functional. Usually, a minimum of one power/switch pack is required per circuit and/or area of control. However in some cases additional power/switch packs may be required. Contact manufacturer for final determination of power/switch packs required for this project.
- G. Locate power/switch packs on wall above ceiling directly over the standard wall switch where possible.
- H. Wall switches shown in spaces with occupancy sensors shall be wired to override the sensor so that the lights can be switched off manually.
- I. In spaces shown with multiple sensors, wire the sensors in parallel so that either sensor can control all of the fixtures on that circuit.
- J. Mount ceiling type devices in the center of a ceiling tile.

3.2 STARTING EQUIPMENT AND SYSTEMS

- A. Occupancy Based Lighting Control - System Commissioning:
 - 1. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system.
 - 2. If multiple trips by the factory technician is required because the system is not operational or completely installed - it is the contractors responsibility to pay for additional service trips.
 - 3. The Contractor shall provide both the manufacturer and the Architect a written notice of the scheduled commissioning date at least 15 working days prior to the scheduled date.

4. Upon completion of the system fine tuning the factory authorized technician shall provide proper training to the Owner in the adjustment and maintenance of the sensors.
5. The Contractor shall provide all lifts and/or ladders and one technician to assist in the commissioning.
6. Prior to commissioning, the Contractor shall verify that all sensors and associated power supplies/relays are installed and all wiring properly terminated.
7. The manufacturer's factory authorized technician shall, upon completion of the commissioning, provide a written report to the Contractor and the Architect indicating completion of the work. This report shall also indicate any corrective actions required on the part of the Contractor.

END OF SECTION 26 5200

SECTION 27 1005 - STRUCTURED CABLING FOR VOICE AND DATA - INSIDE-PLANT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications identification.
- F. Telecommunications service entrance to building(s).
- G. Cabling and pathways inside building(s).
- H. Cabling and pathways connecting building(s).
- I. Distribution frames, cross-connection equipment, enclosures, and outlets.
- J. Grounding and bonding the telecommunications distribution system.
- K. Administration and Labeling
- L. Testing

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Electrical system grounding and bonding.
- C. Section 26 0529 - Hangers and Supports
- D. Section 26 0534 - Conduit.
- E. Section 26 0536 - Cable Trays for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling; 2006.
- B. NFPA 70 - National Electrical Code, 2017 Edition; National Fire Protection Association.

- C. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2018.
- D. TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2012).
- E. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Rev C, 2009 (with Addenda; 2014).
- F. TIA/EIA-568-B.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables
- G. TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces; Rev C, 2012 (with Addenda; 2013).
- H. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2017c.
- I. TIA-606-B - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.
- J. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev B, 2012 (with Addenda; 2013).
- K. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
- L. GTDM - State of Georgia Telecommunications Design Manual; latest edition.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
 - 3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods and instructions.
- B. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).

- C. Shop Drawings shall also include outlet numbering and identifier assignments.
- D. Manufacturer Qualifications.
- E. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- F. Field Test Reports.
- G. Test results verifying that all equipment has been tested for compatibility as part of a structured cabling system.
- H. Project Record Documents (shall be prepared and approved by a RCDD):
 - 1. Provide copy of all approved submittals.
 - 2. Provide full size as-built drawings (minimum "D" size).
 - 3. As-built drawings shall accurately record location of service entrance conduit, termination backboards, outlet boxes, cable raceways, cable trays, pull boxes, and equipment racks electronically and on full size prints.
 - 4. The LVLTC shall prepare 11"X17" as-built serving zone drawings for each Telecommunications Room (TR). The drawings shall be laminated, framed and secured to the wall in the Main Equipment Room (MER) and Telecommunications Room (TR).
 - 5. Provide copy of all test reports.
 - 6. Copper cable records shall include the status of each copper pair. Optical fiber cable records shall include strand allocation, test results, and identification of media and protocol used.
 - 7. Record actual locations of outlet boxes and distribution frames.
 - 8. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 9. Identify distribution frames and equipment rooms by room number on contract drawings.
 - 10. Provide three copies, complete and bound.
 - 11. Provide copies of all manufacturer's warranties.
- I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.
- J. Other Required Project Information (To be provided prior to Pre-Final of the building, for each of the specified media):
 - 1. Cable identification numbers.
 - 2. Cable design makeup.
 - 3. Cable lengths between splice points and terminations.
 - 4. Exact routing of cable.
 - 5. Strand count, mode of installed fiber, loss per splice in dB, and total amount of optical fibers installed.
 - 6. Bonding and grounding.
 - 7. Location and description of all associated structures and obstructions.
 - 8. Cable entrance locations and penetration details.

9. Terminal information, outlet numbering, and pair count information at each distribution frame.
10. Schematic drawings of riser.
11. Routing of cable and termination information.
12. Cable pair counts per connector block.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 3 years' experience manufacturing products of the type specified.
- B. Installer Qualifications:
 1. The telecommunications installation contractor shall be licensed in the State of Georgia as a Low Voltage Licensed Telecommunications Contractor (LVLTC).
 2. The Contractor shall provide an on-site, full-time Project Manager who will act as a single point of contact for all activities regarding this project.
 3. The LVLTC Project Manager shall make on-site decisions regarding the scope of the work and any changes required by the work.
 4. The Project Manager shall be on the job any time work is being performed or workers are present. The PM shall get written approval prior to committing.
 5. The Project Manager shall be totally responsible for all aspects of the work.
 6. The selected LVLTC shall be fully capable and experienced in the telecommunications distribution system to be installed.
 7. The LVLTC shall have a minimum of five (5) years of experience installing Structured Cabling Systems and be a certified installer of the approved cable/component system solution.
 8. The LVLTC shall have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for the project. The credentials (current BICSI certification stamp) of the responsible RCDD shall be attached to the LVLTC's response for evaluation by the State.
 9. A BICSI Certified installer shall be employed by the LVLTC and be on site as the installation manager.
 10. The LVLTC shall provide a minimum of three (3) projects where similar work, both in scope and design, have been completed by the LVLTC within the last two (2) years.

1.7 WARRANTY

- A. The LVLTC shall furnish a warranty of products, applications and workmanship for fifteen (15) years from the date of acceptance by the State. All other products and workmanship shall carry warranties equal to or greater than the warranty from the date of acceptance by the State.
- B. Materials and workmanship shall be fully guaranteed by the LVLTC for fifteen (15) years from the date of acceptance by the State. Defects which may occur, as the result of faulty materials or workmanship, within fifteen (15) years after installation and acceptance by Owner shall be corrected by the LVLTC at no additional cost to Owner.

- C. The period of the LVLTC's warranty (ies) for any items herein are not exclusive remedies, and Owner has recourse to any warranties of additional scope given by LVLTC to Owner and all other remedies available at law or in equity.
- D. The LVLTC shall pass along to Owner any additional warranties offered by the manufacturers, at no additional costs to Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cabling:
 - 1. Superior Essex
 - 2. General Cable
 - 3. CommScope
 - 4. Belden
 - 5. Hitachi
 - 6. Draka
 - 7. Mohawk
 - 8. Berk-Tek
- B. Connectivity:
 - 1. Panduit
 - 2. Hubbell
 - 3. Siemon
 - 4. Ortronics
 - 5. Leviton
 - 6. Molex
 - 7. CommScope
 - 8. Hellermann Tyton
- C. Racks:
 - 1. X-Mark
 - 2. Chatsworth
 - 3. Homaco
 - 4. Great Lakes
 - 5. Eaton Cooper B-Line
- D. The system used shall be a certified systems solution comprised of the manufacturers listed above. Manufacturers offering their system solution using their cable and components shall be acceptable.

2.2 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for telecommunications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Comply with TIA-568 (SET) (cabling) and TIA-569-C (pathways), latest editions (commercial standards).

2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607-B and are UL listed or third party independent testing laboratory certified.
 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
 5. Comply with the latest adopted version of the GTDM.
- B. Telecommunications cabling, jacks, patch panels, punch down blocks and other equipment shall be certified for Category 6 operation.
- C. All UTP copper cables shall be terminated in rack mounted patch panels. There is no distinction between voice and data cables in a structured cabling system.
- D. Products including, but not limited to, cabling, jacks, patch panels, and cabinets shall be consistent throughout the project. All equipment shall have been tested for compatibility as part of a structured cabling system.
- E. Active equipment (handsets, hubs, switches, media converters, etc.) is not included in this contract unless otherwise noted.
- F. Main Equipment Room (MER): Centrally located support structure for terminating backbone cables, functioning as point of presence to external service provider.
1. Locate main distribution frame as indicated on the drawings.
 2. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- G. Telecommunications Rooms (TRs): Support structures for terminating horizontal cables that extend to telecommunications outlets.
1. Locate telecommunications rooms as indicated on the drawings.
- H. Backbone Cabling: Cabling, pathways, and terminal hardware connecting telecommunications rooms (TRs) with the main equipment room (MER), wired in star topology with the MER at center hub of star.
- I. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".
- J. Copper Horizontal Cable (defined as cable from the Work Area to the patch panel): TIA/EIA-568 Category 6 solid conductor unshielded twisted pair (UTP), 24 AWG, 100 ohm; 4 individually twisted pairs; covered with blue jacket and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444. Cables routed in conduit that goes below the slab shall be listed for wet locations. These cables must terminate directly in the data room and shall not be routed exposed in the building.

2.3 PATHWAYS

- A. Conduit: Refer to Section 26 0534 for general conduit specifications regarding routing. This does not mean conduit shall be 1/2" in size; data conduits shall not be less than 1". provide pull cords in all conduit.

1. Conduit for horizontal cable distribution shall be minimum 1" trade size. This is considered conduit from the work area outlet, up and out of the wall over to the cable tray. Do not stub the conduit just out of the wall and then J hook over to the cable tray - this is unacceptable. Conduit must be routed to the nearest cable tray.
 2. Provide insulated bushings at each end of all conduits.
 3. All riser and entrance conduits shall be minimum 4" in diameter.
 4. All conduits to receive fiber optic cable shall be provided with three 1-1/4" innerducts.
- B. Cable Trays: As specified in Section 26 0536.
- C. Sleeves: Minimum 4" threaded galvanized rigid steel conduit with plastic insulating bushing on each end.
- D. Ladder Rack:
1. Shall be tubular side bar type nominally 3/8" thick by 1-1/2" high (minimum) with 1/2" x 1" welded rungs spaced 9" on center.
 2. Shall be powder coated and black in color.
 3. Shall include connecting and all other support hardware for a complete installation.
 4. Shall include equipment rack to runway mounting plates, wall angle support brackets, butt splice swivels, junction splice connections and grounding kits.
- E. Vertical Ladder Rack:
1. Provide ladder rack as required for backbone cables passing vertically through TRs and/or ERs.
 2. Include connecting hardware and all other support hardware for a complete installation.
 3. Provide with grounding lug to allow for bonding connection.
 4. Shall be tubular side bar type nominally 3/8" thick by 1-1/2" high (minimum) with 1/2" x 1" welded rungs spaced 9" on center.
 5. Shall be powder coated and black in color.

2.4 COPPER CABLE AND TERMINATIONS

- A. Copper Backbone Cable: TIA/EIA-568 Category 6 solid conductor unshielded twisted pair (UTP), 24 AWG, 100 ohm; 100 pairs formed into 25-pair binder groups; covered with gray thermoplastic jacket and complying with all relevant parts of and addenda to latest editions of TIA/EIA-568 and ICEA S-90-661, and UL 444.
1. In locations other than in plenums, provide NFPA 70 type CMR riser-rated or type CMP plenum-rated cable, except as described below.
 2. In plenums, provide NFPA 70 type CMP plenum-rated cable.
 3. All cable routed under slab on grade shall be wet location listed for that condition. Cable shall transition to the type described above as soon as practicable upon penetrating the slab. The transition shall NOT be in a plenum.
 4. Provide cable having conductors twisted at minimum rate of two per foot; actual length and frequency of twists at manufacturer's option.
 5. Color code conductors in accordance with ICEA S-90-661.
- B. Copper Horizontal Cable (defined as cable from the Work Area to the patch panel): TIA/EIA-568 Category 6 solid conductor unshielded twisted pair (UTP), 24 AWG, 100

ohm; 4 individually twisted pairs; covered with blue jacket and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444. Cables routed in conduit that goes below the slab shall be listed for wet locations. These cables must terminate directly in the data room and shall not be routed exposed in the building.

1. All cable shall be NFPA 70 type CMP plenum-rated, except as described below.
2. All cable routed under slab on grade shall be wet location listed for that condition. Cable shall transition to the type described above as soon as practicable upon penetrating the slab. The transition shall NOT be in a plenum.
3. Testing: Furnish factory reel tests.
4. Cables shall be marked with the manufacturer's name, cable type/catalog number and the latest adopted NEC code compliance.

C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool.

D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.

1. Performance: 500 mating cycles.
2. Outlet Jacks: 4-pair, pre-wired to T568B configuration, with color-coded indications for T568B configuration.

2.5 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Fiber Optic Interconnecting Devices:

1. Connector Type: Type SC.
2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
3. Maximum Attenuation/Insertion Loss: 0.3 dB.

B. Single Mode Fiber Optic Backbone Cables:

1. See plans for required strand count.
2. Shall be NFPA 70 type OFNP nonconductive-plenum-rated.
3. Class IVa dispersion – un-shifted single mode optical fibers complying with ANSI/EIA/TIA-492BAAA.
4. The zero dispersion wavelength shall be between 1300 nm and 1324 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.093 ps/km-nm².
5. Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175.
6. The nominal mode field diameter shall be 8.7 um.
7. Maximum attenuation dB/Km @ 1310/1550 nm: 1.0/1.0.
8. The cutoff wavelength shall <1279 nm when measured in accordance with ANSI/EIA/TIA-455-170.
9. Shall be 900 um tight buffer.
10. Shall have 2.0 mm sub-unit diameter.
11. Shall be suitable for indoor installations.
12. Strength members shall be all dielectric.
13. Shall incorporate secondary thermoplastic type buffer over each fiber.

14. Shall have individual fiber tube colors per ANSI/TIA/EIA-606A with an overall orange jacket.
15. Provide stiff central member with cables stranded around center.
16. Provide ripcord for overall jacket.
17. The operating temperature range shall be between -20 to 70 degrees centigrade.
18. Shall be factory certified per reel. The certification shall consist of instrument readings from an Optical OTDR noting dB loss per meter, fiber index of refraction and laser wave length. An OTDR test data sheet shall be provided with photograph of graphical output showing display, cable reflectometer trace and all settings.

C. Multimode Fiber Optic Backbone Cables:

1. See plans for required strand count.
2. Shall be NFPA 70 type OFNP nonconductive-plenum-rated.
3. Shall be graded-index optical fiber with nominal 50/125mm core/cladding diameter.
4. Primary coating diameter of 250um UV cured acrylate buffer material.
5. The fiber shall comply with ANSI/EIA/TIA-492AAAB.
6. Attenuation shall be measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61.
7. Information transmission capacity shall be measured in accordance with ANSI/EIA/TIA-455-51 or 30.
8. The measurements shall be performed at 23 degrees C +/- 5 degrees.
9. Maximum attenuation dB/Km @ 850/1300 nm: 3.25/1.0.
10. Bandwidth 200 MHz-km @ 850nm.
11. Bandwidth 800 MHz-km @ 1300nm.
12. Shall be 900 um tight buffer.
13. Shall be suitable for indoor installations.
14. Strength members shall be all dielectric.
15. Shall incorporate secondary thermoplastic type buffer over each fiber.
16. Shall have individual fiber tube colors per ANSI/TIA/EIA-606A and an overall orange jacket.
17. Provide stiff central member with cables stranded around center.
18. Provide ripcord for overall jacket.
19. The operating temperature range shall be between -20 to 70 degrees centigrade.
20. Shall be factory certified per reel. The certification shall consist of instrument readings from an Optical OTDR noting dB loss per meter, fiber index of refraction and laser wave length. An OTDR test data sheet shall be provided with photograph of graphical output showing display, cable reflectometer trace and all settings.
21. Provide NFPA 70 type OFNP nonconductive-plenum-rated cable for all interior fiber optic cable.

D. Fiber Optic Adapters and Connectors: Duplex SC, push-on-push-off type, multimode adapters with zirconia ceramic alignment sleeves; complying with relevant parts and addenda to latest edition of TIA/EIA-568 and with maximum attenuation of 0.3 dB at 1300 nm with less than 0.2 dB change after 500 mating cycles when tested in accordance with TIA-455-21.

1. The 568SC connectors shall meet TIA/EIA-604-3 standards.
2. The total optical attenuation through the cross-connect from any terminated optical fiber to any other terminated fiber shall not exceed 1.0 dB.
3. The connectors shall have a return loss greater than or equal to 20 dB for multimode fiber and greater than or equal to 26 dB for single mode fiber.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with TIA-606-B.

2.7 CROSS-CONNECTION EQUIPMENT

- A. Connector Blocks for Category 5e and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
 - 1. The connecting hardware block shall facilitate cross-connection and/or inter-connection using either approved cross-connect wire or patch cords.
 - 2. Blocks shall be UL Verified.
 - 3. Shall be TIA/EIA-568 Category 6 compliant.
 - 4. Shall be made of flame-retardant thermoplastic.
 - 5. Shall be 50, 100 or 300 pair sizes, as required for the actual cables being terminated.
 - 6. Blocks shall include means to identify cables/services per TIA/EIA-606A.
 - 7. Shall have connecting blocks used for either the termination of cross-connect (jumper) wire or patch cords. The connecting blocks shall be available in 3, 4 and 5 pair sizes. All connecting blocks shall have color-coded tip and ring designation markers and be of single piece construction.
 - 8. Shall support wire sizes: Solid or 7-strand 22-26 AWG.
- B. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface.
 - 1. Jacks: Eight position non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel. No 24 port patch panels allowed.
 - a. Shall be modular type.
 - b. Shall be available in universal wiring schemes (Use T568B).
 - c. Housing shall be fire retardant UL 94VO rated thermoplastic and tin lead solder plated IDC.
 - d. Housing shall be fully encased to protect printed circuit board and IDC fields.
 - e. Modular jack contacts shall accept a minimum of 2500 plug insertions without degradation of electrical or mechanical performance.
 - f. Modular jack contacts shall be constructed of Beryllium copper.
 - g. Shall utilize a paired punch down sequence. Cable pairs and sheath shall be maintained up to the IDC.
 - h. Shall be compatible with single conductor, industry standard 110 type impact termination tools.
 - i. Shall include means to hold terminated wires in place.
 - j. Shall have an attached color-coded wiring label.
 - k. Shall be UL Verified and listed for TIA/EIA Category 6 electrical performance.
 - 2. Shall accommodate 48 ports for each rack mount space. No high density port configurations allowed.
 - 3. Panel circuit boards shall be fully enclosed front and rear for physical protection.
 - 4. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.

5. Labels: Factory installed laminated plastic nameplates above each port (front and back), numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
 6. Panels shall provide wiring identification and color code and maintain a paired punch down sequence that does not require the overlapping of cable pairs.
 7. Panels shall be Category 6 compliant.
 8. Provide incoming cable strain relief and routing guides on back of panel.
- C. Rack Mounted Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
1. Adaptors: As specified above; maximum of 24 duplex adaptors per standard panel width.
 2. Shall be available in 12, 24, 48, 72, and 96 port configurations.
 3. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
 4. Provide incoming cable strain relief and routing guides on back of panel.
 5. Provide rear cable management tray at least 8 inches deep with removable cover.
 6. Provide dust covers for unused adaptors.
 7. Provide for cross-connections or inter-connections.
 8. Provide with front access design with hinged bulkhead plate. Front cover shall be removable.
 9. Panels shall accommodate stackable splice trays, which manage up to 24 splices per tray.

2.8 ENCLOSURES

- A. Backboards: Interior grade plywood without voids, 3/4 inch thick.
1. Size: 48 inches wide by 96 inches high.
 2. Do not paint over UL label.
- B. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.
1. Floor Mounted Equipment Racks:
 - a. Shall be standard 84" in height.
 - b. Shall have a universal junction hole pattern.
 - c. Shall have #12-24 panel mounting holes.
 - d. Shall be capable of supporting a maximum load of 600 Lbs.
 - e. Shall be constructed of aluminum alloy.
 - f. Shall be finished with flat black powder coat paint.
 - g. Cable management units shall be black metal.
 - h. Provide with both vertical and horizontal cable management.
 - i. Shall be provided with grounding lug.
 - 1) Vertical cable management panels shall have front and rear channels, both with removable covers.
 - 2) A horizontal manager shall be provided at the top of each rack, with a minimum height of 2 rack units each.
 - 3) Horizontal cable management panels shall also have front and rear channels.
 - 4) Provide horizontal managers above and below each patch panel, with a minimum height of 2 rack units each.
 2. Wall Mounted Cabinets:

- a. Shall be 48" high with 24 mounting spaces.
 - b. Shall be of lightweight, high strength steel construction.
 - c. Shall be provided with a 19" Equipment Grounding Bar (as per manufacturer's recommendations to comply with NEC).
 - d. Shall have a black powder coat finish.
 - e. Shall have a minimum 100 lb. loading capacity.
 - f. Shall be of 16 gauge welded steel construction.
 - g. Static weight capacity shall be 800 Lbs. minimum.
 - h. Shall have minimum 45 available rack units.
 - i. Plexi-glass window.
 - j. Removable vented side covers.
 - k. With 19" power strip.
 - l. With #10-32 x 5/8" screws for mounting equipment.
 - m. Integrated vertical cable management.
 - n. One horizontal wire management panel (minimum 3") above and below each piece of equipment.
 - o. Universal mounting rails with 10/32 AND 12/24 tapped holes.
 - p. 5/8" and 1/2" EIA standard hole pattern.
 - q. 19" Equipment Grounding Bar (as per manufacturer's recommendations to comply with NEC).
 - r. Black powder coat finish.
 - s. Knockouts in top and bottom for cable access.
 - t. Both front and rear access shall be lockable.
- C. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
1. Size, Unless Otherwise Indicated: 4 inches square by 2-1/8 inches deep. Provide with single gang plaster ring.
 2. Faceplates: Type 302 stainless steel, complying with system design standards and UL 514C.
 - a. Shall accept up to six jacks in a single gang configuration.
 - b. Jacks to be installed in wet or corrosive environments shall be installed in faceplates designated for that purpose.
 3. Modular Furniture Adapter Plates:
 - a. Plates shall be made of high impact UL 94VO rated thermoplastic.
 - b. Plates shall be UL listed.
 - c. Plates shall snap into the modular furniture opening and be retained by integral latching tabs.
 4. Multimedia Housings:
 - a. Outlet shall be capable of accommodating up to 12 cables, of any combination of media.
 - b. Outlet ports shall be located on the bottom when the outlet is mounted to a vertical surface.
 - c. Outlet base shall have mounting holes that will allow it to be mounted to a double-gang wall box.
 - d. Outlet shall be UL listed.
 - e. Outlets shall be made of high impact UL 94VO rated thermoplastic.
 - f. Outlet shall be field configurable for use with multiple cable types and shall have brackets for UTP, BNC, F, and RCA connectors, and small form factor optical fiber connectors.

5. All jacks shall be installed in faceplates.
6. Where different media is shown to terminate in the same location, provide in the same faceplate.

2.9 GROUNDING AND BONDING

- A. Telecommunications Grounding Busbar (TGB):
 1. Copper Ground Bar (Minimum 1/4"x4"x23")
 2. Provide with insulators and a support bracket for isolation.
 3. Provide lugs for each bonding conductor and the telecommunications bonding backbone. Terminals shall be solderless compression type, copper long barrel NEMA two bolt.
- B. Ground Lugs:
 1. Hardware (bolts), bonding connectors and clamps shall be silicone bronze.
 2. The copper alloy lug shall be sized for connecting to the Telecommunications Main Grounding Busbar (TMGB) with the Bonding Conductor (BC) and the Telecommunications Bonding Backbone (TBB).
- C. Rack Mounted Equipment Ground Bar:
 1. Provide a 3/16"x3/4"x18-5/16" bar for attachment to the 19" mounting rails of equipment racks and cabinets.
 2. Provide #6-32 silicon bronze screws, ground lugs and other mounting hardware to serve as a splice plate for attachment to multiple racks (if applicable).

2.10 ADMINISTRATION AND LABELING

- A. Horizontal Cables: Self-adhesive, self-laminating, mechanically printed with a clear protective laminating over-wrap or mechanically printed heat shrink tubing.
- B. Cable Trays: Minimum three inch square surface area tag, mechanically stamped. Acceptable tagging materials are copper, brass or 1/16 inch plastic.
- C. Equipment Bonding Conductor: Self-adhesive, self-laminating, mechanically printed with a clear protective laminating over-wrap or mechanically printed heat shrink tubing.
- D. Entrance Conduits: Minimum three inch square surface area tag, mechanically stamped. Acceptable tagging materials are copper, brass or 1/16 inch plastic.
- E. Telecommunications Grounding Busbar (TGB): Minimum three inch square surface area tag, mechanically stamped. Acceptable tagging materials are copper, brass or 1/16 inch plastic.
- F. Equipment Racks and Cabinets: Nameplates shall be white with black core laminated phenolic nameplates with 3/8 inch lettering etched through the outer covering.
- G. UTP Patch Panels: Nameplates shall be white with black core laminated phenolic nameplates with 3/8 inch lettering etched through the outer covering.

- H. Pull Boxes: Provide 3/4" black stenciled letters on a painted orange rectangular background.
- I. Telecommunications Main Grounding Busbar (TMGB): Minimum three inch square surface area tag, mechanically stamped. Acceptable tagging materials are copper, brass or 1/16 inch plastic.
- J. Work Area Outlets: White 3/8" self-adhesive Mylar tape with 1/4" black, mechanically produced lettering.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569-C (pathways), TIA-607-B (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with Communication Service Provider requirements.
- C. Grounding and Bonding: Perform in accordance with TIA-607-B and NFPA 70.
- D. The Licensed Low Voltage Telecommunications Contractor (LVLTC) shall install work in accordance with the BICSI Cabling Installation Manual and the latest GTDM.

3.2 BACKBOARDS

- A. Install backboards 6" above finished floor to 8'-6" above finished floor.
- B. Attach plywood to the wall with 1/4 inch toggle bolts.
- C. Coat frame and backboard with two coats of white enamel paint with fire retardant additive.
- D. Provide on all walls of Telecommunications Rooms (TRs) and Main Equipment Room (MER).
- E. Install distribution rings for the cross-connect fields above all wall mounted blocks. Provide two rings per vertical row of blocks. Mount rings with two hex head screws per ring.

3.3 INSTALLATION OF PATHWAYS

- A. Install pathways with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit:

1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
2. Runs exceeding 100 feet or 180 degrees total bends shall be broken with suitable sized pull boxes. Pull boxes shall not be located at bends.
3. Factory made large radius sweeps shall be used for 1" trade size and larger.
4. Conduit for horizontal cables shall extend to within 1 inch of top edge of cable tray.
5. Conduit runs to work areas shall serve no more than one Work Area Outlet (WAO).
6. Leave pull cords in place where cables are not initially installed.
7. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
 - a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
 - b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
 - c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
 - d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.

C. Sleeves:

1. For horizontal cable distribution, provide 4-inch conduit sleeves from the MER and each TR into the adjacent corridor above the room entrance door and to any other adjacent high cable count entry point.
2. Provide a minimum four 4" sleeves at each location described above.
3. Attach cored sleeves on each side of the floor/wall using 1.25" support struts and the appropriate conduit clamps to support the sleeves.
4. Cored sleeves shall extend a minimum of 3-inches AFF and 3-inches below the poured concrete structure.
5. Cored holes shall be sealed as a barrier to prevent smoke and water infiltration between the cored hole and the conduit.
6. Place vertical ladder rack on the wall below or above all sleeves from the floor to the ceiling above.

D. Ladder Rack:

1. Provide in all TRs and MER to support cables not on racks.
2. Shall be installed on all walls around the perimeter of TRs and MER.
3. Shall be mounted to the plywood backboard at 7'-0" AFF and attached to the top of all equipment racks in the space.
4. Support at three foot intervals from either the ceiling, walls, floor, or rack/cabinet.
5. Cable radius drops (waterfalls) shall be attached to the ladder rack stringers or rungs to facilitate cable entering and exiting the runway while protecting the physical properties of the cable.
6. Cables shall be secured to the runway using reusable cable ties to arrange cable in logical bundles.

E. Vertical Ladder Rack:

1. Install on plywood backboard and/or wall above/below all sleeves from the floor to ceiling above.
2. Stand-offs shall be installed as necessary to support the required ladder rack.
3. The anchoring system provided shall be suitable for the type of wall and the weight to be supported by the ladder rack.

- F. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.

3.4 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:

1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair (horizontal) use bend radius of not less than 4 times cable diameter.
2. Do not over-cinch or crush cables.
3. Do not exceed manufacturer's recommended cable pull tension.
4. Cables shall not be bound tightly by plastic straps in a manner that distorts cables or jackets. Use VELCRO ties only - no cable ties allowed.
5. Install in accordance with the BICSI Installation Manual.

B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:

1. At Distribution Frames: 180 inches.
2. At Outlets - Copper: 12 inches.
3. At Outlets - Optical Fiber: 39 inches.

C. Copper Backbone Cabling:

1. Cable bend radius shall be maintained to at least 10 times the diameter of the cable.
2. Cable feeder guides shall be used between the cable reel and the conduit.
3. Cable shall be inspected for sheath defects as it is spooled off of the reel. Pulling operation shall be stopped if a defect or any other irregularity is found. Spool cable off from the top of the reel.
4. Use a line tension meter during cable pull to provide accurate measurement of the force exerted on cable. The meter shall have controls to disengage the cable puller if an overload condition occurs.
5. Ground and bond all cable shields per the NEC and TIA/EIA-607.
6. All installed pairs shall be terminated on both ends.

D. Copper Horizontal Cabling:

1. Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
2. Jacks shall be installed such that cables terminated to the jacks maintain a minimum bend radius of at least 4 times the cable diameter.
3. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.
4. Provide one cable per jack. No sharing of pairs is allowed.
5. All horizontal UTP cables shall be terminated in patch panels.
6. All horizontal UTP cables concealed in walls or soffits shall be installed in metal conduits.
7. All horizontal UTP cables shall be installed in wire management systems consisting of conduit and/or cable tray continuous from the work area outlet to the TR or MER.
8. Maximum installed horizontal UTP cable length shall not exceed 250 feet.
9. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.

10. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.
 11. Maintain the following clearances from EMI sources:
 - a. Power - 12 inches
 - b. Fluorescent Lights - 12 inches
 - c. Transformers - 36 inches
- E. Fiber Optic Backbone Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 2. Support vertical cable at intervals as recommended by manufacturer.
 3. No fiber optic cable splices are allowed. All fiber strands shall be terminated using connectors specified herein.
 4. All fiber optic cables shall be installed in plenum rated innerduct. All innerducts shall be in metal conduits.
 5. A pulling lubricant which is compatible with the low density sheath may be used to minimize friction of the optical fiber cable within the innerduct walls.
 6. If mechanical or electrical winching devices are used to pull the cable, the cable tension shall be monitored with a commercial dynamometer or load-cell to ensure that the manufacturer's pulling specifications are not exceeded.
 7. Use kellum type pulling grips and swivel designed for fiber optic cable pulling.
 8. Pulling wheels shall be used when pulling around sharp corners in conduits.
 9. The cable jacket shall not be cut or damaged in any way that would expose fiber strands inside.
 10. Vertical runs shall be pulled from the top down. Tension shall be relieved for cables which are to continue to the next floor by looping the cable (two feet diameter) on each floor on the backboards with cable ties.
 11. Install buffered tubing (from fan-out kit) over the fiber, secure the buffered tubing to the splice tray, run the fan-out tubing up into the fiber enclosure, and install the connectors.
 12. Provide maximum length of excess fan-out cable for termination.
 13. Neatly tie all cables in loose bundles as they enter the fiber optic patch panel.
 14. Install fiber cables paired 1-2, 3-4, 5-6 top down in fiber optic patch panels.
 15. Where fiber optic cables pass vertically through slots and sleeves, secure the cable every 18" to the vertical ladder rack.
 16. Fiber optic cables shall be labeled per TIA/EIA-606A standards.
 17. Connectors shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.
 18. Fibers shall be terminated such that there is no tension on the conductors in the termination contacts.
 19. Install blank adapter panels in all positions not used in fiber optic patch panels.
- F. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
1. Racks shall be assembled such that mounting rails are perpendicular to the base.
 2. Shall be secured to the ladder rack as per the ladder rack manufacturer's recommendations.
 3. Mount with a minimum of 36" clear access behind and in front of each rack or enclosure.

- G. Identification:
 - 1. Use wire and cable markers to identify cables at each end.
- H. Faceplates and Adapter Plates:
 - 1. Sufficient cable slack shall be stored behind the faceplate in such a way that allows the manufacturer's specified minimum bend radius of the cables to be maintained.
 - 2. Shall be securely mounted to the mounting bracket.
 - 3. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.

3.5 GROUNDING AND BONDING

- A. Perform in accordance with TIA J-STD-607 and NFPA 70.
- B. Install a grounding busbar in each telecommunications Equipment Room and Telecommunications Room.
- C. Provide a minimum #6 AWG copper, insulated ground wire from the TGB to the main building grounding electrode system.
- D. All metallic equipment racks, conduits, cable trays, ladder racks, etc. shall be bonded to the grounding busbar using minimum #6 AWG copper.
- E. Bond the shield of shielded cable to the ground bar in communications rooms and spaces, per applicable code and manufacturers recommended practices.

3.6 ADMINISTRATION AND LABELING

- A. All labeling shall be per TIA/EIA-606A standards.
- B. Hand written labels are not acceptable.
- C. Horizontal Cables:
 - 1. Permanently secure the label within 6 inches from both ends of the cable and at all pull boxes.
 - 2. Label shall indicate TR (or MER), patch panel and port to which the horizontal cable is terminated.
- D. Cable Trays: Permanently secure the labels on both sides of the cable tray at 10 foot intervals and at both ends of the cable tray.
- E. Equipment Bonding Conductor: Permanently secure the tag within 6 inches from both ends of the equipment bonding conductor.
- F. Service Entrance Conduits: Permanently secure the tag within 6 inches from both ends of the entrance conduit and at all access points.
- G. Telecommunications Grounding Busbar (TGB): Permanently secure the label within 6 inches of the busbar.

- H. Equipment Racks and Cabinets: Permanently secure the labels to the top center portion of the front of the rack/cabinet.
- I. Patch Panels: Fiber and copper patch panels shall come labeled from the factory with port number designations.
- J. Pull Boxes: Permanently mark all pull boxes on the cover and on at least one side.
- K. Telecommunications Main Grounding Busbar (TMGB): Permanently secure the label to the wall or backboard within 6 inches of the TMGB.
- L. Work Area Outlets (WAO):
 - 1. Copper UTP cables terminated in a WAO shall be labeled to indicate the following: TR or MER designation, patch panel, and port number to which that cable is terminated.
 - 2. Fiber optic cables terminated in a WAO shall be labeled to indicate the following: the origination and destination TRs or MER, and the individual strand ID.
 - 3. Permanently secure the label to the WAO.

3.7 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- D. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Test operation of shorting bars in connection blocks.
 - 4. Category 6 Backbone: Perform near end cross talk (NEXT) and attenuation tests.
 - 5. Category 6 Links: Perform tests for wire map, length, DC continuity, attenuation, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, and propagation delay.
 - 6. Utilize a Level IIe tester for Category 6 link compliance. If any part of the installed system results in a "FAIL" indicator on the tester, the problem shall be analyzed and corrected.
 - 7. Testers shall be correctly set to test the type and manufacturer of the horizontal cable used in the link being tested, including the correct NVP.
- E. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.

2. Multimode Backbone: Perform tests in accordance with TIA-526-14.
 3. Single Mode Backbone: Perform tests in accordance with TIA-526-7 Method B.
 4. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.
- F. Complete testing at least two weeks before the scheduled final site observation. Provide test results prior to the final.
- G. The manufacturer providing the system warranty shall certify the test results.
- H. Replace work considered unacceptable to Architect as a prerequisite to system acceptance.
- I. As part of the submitted test report, provide a sheet stating the acceptable limits for each test, and the Standard Agency and reference where that limit is stated.
- J. Identify each test by the WAO identifier.
- K. All testing shall be done in accordance with TIA/EIA TSB67.
- L. Provide submittals to GTA as specified above.

END OF SECTION 27 1005

SECTION 28 3100 - FIRE ALARM SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.

1.2 RELATED SECTIONS

- A. Section 07 8400 - Firestopping: Materials and methods for work to be performed by this installer.
- B. Section 21 3000 - Fire Pumps: Supervisory devices.
- C. Section 21 1300 - Fire-Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
- D. Section 23 3300 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code, 2017 Edition, National Fire Protection Association.
- B. NFPA 72 - National Fire Alarm Code, 2019 Edition.
- C. NFPA 101 - Life Safety Code, 2018 Edition with all Georgia State Modifications.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Shop Drawings: Submit all information required for plan review and permitting, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Notify the State Fire Marshal's Office, via SFM Form 354A, prior to beginning of installation of fire alarm system and submit three copies of complete information regarding system, in compliance with NFPA 72, National Fire Alarm and Signaling Code, 2013 Edition, Chapters 7 and 10.
 - 2. NFPA 72 "System Record of Completion", filled out to the extent known at the time.
 - 3. System zone boundaries and interfaces to fire safety systems.
 - 4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.

5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 6. List of all devices on each signaling line circuit, with spare capacity indicated.
 7. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 8. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 9. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 10. Certification by the manufacturer of the control unit that the system design complies with the contract documents.
 11. Certification by Contractor that the system design complies with the contract documents.
- C. Evidence of installer qualifications.
- D. Evidence of instructor qualifications; training lesson plan outline.
- E. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "System Record of Inspection and Testing," filled out.
- F. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- G. Project Record Documents: See Section 01 7800 for additional requirements; have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- H. Closeout Documents:

1. Certification by manufacturer that the system has been installed in compliance with his installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "System Record of Completion", filled out completely and signed by installer and authorized representative.
3. Report on training results.

1.5 QUALITY ASSURANCE

- A. Copies of Shop Drawings: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines; deliver to Owner upon completion.
- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level 3 certified fire alarm technician; furnish name and address.
 4. Contract maintenance office located within 50 miles of project site.
 5. Certified in Georgia as fire alarm installer.
- C. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- D. All components of the Fire Alarm System shall be cross-listed by Underwriter's Laboratories, Inc., for installation in a common system.
- E. All control equipment shall be listed under UL category UOJZ as a single control unit.

1.6 EXTRA MATERIALS AND TOOLS

- A. Provide spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
- B. In addition to the items in quantities indicated in PART 2, provide the following:
 1. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
 2. CD-ROM copies, 2, of all software not resident in read-only-memory.
 3. Provide documentation cabinet adjacent to FACP as required per NFPA72 Paragraph 7.7.2.1.

1.7 WARRANTY

- A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
- B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units:
 - 1. JCI - Simplex model 4100ES, sole source.

2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in the contract documents or not.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. The Americans With Disabilities Act (ADA).
 - b. The requirements of the State Fire Marshall.
 - c. Applicable local codes.
 - d. The contract documents (drawings and specifications).
 - e. NFPA 101.
 - f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 4. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 - 5. Program notification zones and voice messages as directed by Owner.
 - 6. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
 - 7. Master Control Unit (Panel): New, located at as indicated on the drawings.
- B. Supervising Stations and Fire Department Connections:
 - 1. Public Fire Department Notification: Provide digital encoder to notify the local Fire Department legally committed to serve the area in which the building is located when an alarm condition is initiated on the fire alarm system. Notification shall be via an approved, U.L. listed monitoring service. The encoder shall be U.L. listed; shall be approved by the local authority having jurisdiction; shall be connected to one outside telephone line to serve as the Primary means of transmission AND shall use either IP Communications or Digital Cellular (4G) technology; and shall have a line seizure function. Encoder shall be able to transmit not just Alarm, Supervisory, and Trouble signals, but POINT ID as well, meaning the device

causing the alarm is identified. All programming to do so shall be by the contractor. The contractor shall coordinate with the local Fire Department concerning who/which monitoring service to be notified in the event of the alarm condition. The secondary means of communications described above can be either integral to the DACT or through a separate interface that is NFPA approved and UL certified for this application.

- C. Circuits: Provide class and style wiring as required for this type of construction and facility.
- D. Spare Capacity:
 - 1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 - 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 - 3. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- E. Power Sources:
 - 1. Primary: Dedicated branch circuits of the facility power distribution system.
 - 2. Secondary: Storage batteries.
 - 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 - 4. Each Computer System: Provide uninterruptible power supply (UPS).
- F. Operation:
 - 1. The system alarm operation subsequent to the activation of any manual station, automatic detection device, or sprinkler flow switch shall be as follows:
 - a. All audible alarm indicating devices shall sound an alarm signal until silenced by the alarm silence switch at the control panel.
 - b. All visible alarm indicating devices shall flash continuously until the Alarm Silence Switch is operated.
 - c. Subsequent zone alarms shall reactivate the alarm indicating devices.
 - d. A supervised signal to notify the local fire department shall be activated.
 - e. Supervised relays interlocked with mechanical controls shall initiate the air handling/ventilation sequence in accordance with NFPA 90 and as specified elsewhere in these specifications and as shown on the plans. Provide relays adjacent starting/control devices in separate enclosure painted red.
 - f. Where smoke control dampers are installed, when the smoke detector associated with it activates, smoke dampers shall close as described in the mechanical specifications.
 - 2. The alarm shall be displayed on a multi-character LCD display. The characters shall identify the alarm zone and the device type. The system alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged, the LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control panel. The LCD display shall show the new alarm information.
 - 3. An alarm tone shall occur within the control panel until the event has been acknowledged.
 - 4. The activation of any space type smoke detector shall initiate an Alarm Verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If, within one (1) minute after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm. If no second alarm occurs within one minute the system shall resume normal

operation. The Alarm Verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. Smoke detectors with analog sensitivity, adjustable from the control panel may be used in lieu of alarm verification. The activation of any duct type smoke detector shall send the entire system into a supervisory alarm and shall activate a visual and audible supervisory signal at a constantly attended location.

5. The system shall have a function that will allow the operator to display all alarms, troubles, and supervisory service conditions including the time of each occurrence.
6. Provisions for a future printer to record all events with corresponding times shall be provided.

G. Supervision:

1. The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel. A "power on" LED shall be displayed continuously while incoming power is present.
2. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated on the control panel.
3. All devices, detectors, and all wiring within the system shall be supervised.

H. Power Requirements:

1. The control panel shall receive 120 VAC power.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of twenty-four (24) hours with five (5) minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.

I. Peripheral Network:

1. Communication and Addressable Devices: The system must provide communication with initiating devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:
 - a. Alarm
 - b. Trouble
 - c. Open
 - d. Device missing / failed
2. All addressable devices shall have the capability of being disabled or enabled individually.
3. The system shall have the capability to multidrop up to 400 addressable devices. Systems that require factory reprogramming to add or delete devices are unacceptable.
4. Format: The communication format must be a digital poll/response protocol to allow t-tapping of the circuit wiring. Communication reliability shall be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission portion of the protocol.
5. Identification of Addressable Devices: Each addressable device must be uniquely identified by an address code. Device identification schemes that do not use unique set addresses but rely on electrical position along the communication channel are unacceptable.

6. Wiring Type, Distances, Survivability and Configurations: Wiring types will be approved by the equipment manufacturer. Existing wiring will be utilized in retrofit applications. The system shall allow a line distance of up to 2,500 feet to the furthest addressable device on a Class B circuit. To minimize wire routing and to facilitate future additions, t-tapping of the communications channel will be utilized.

2.3 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 1. Sprinkler water control valves.
 2. Fire pump(s): Trouble signals shall be generated for the following conditions (See NFPA 20, Paragraph 7-4.7, 1999 edition):
 - a. Controller has operated into a motor running condition.
 - b. Loss of line power on line side of motor starter in any phase.
 - c. Phase reversal on line side of motor starter.
 - d. Provide 3 (or number required) addressable detector bases and connect to fire pump controller contacts as required.
 3. Elevator shut-down control circuits.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 1. Sprinkler water flow. See below for interface details.
 2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment. Provide addressable detector bases as required.
 3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
 4. Duct smoke detectors.
 5. Area smoke detectors.
 6. Pullstations.
- C. Elevators:
 1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
 2. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
- D. HVAC:
 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
 2. Provide smoke detectors where smoke control dampers are shown on the mechanical plans. Provide duct detectors where the dampers are located in ductwork, provide area detectors in the plenum where dampers are located in return air openings. The SCDs associated with these detectors shall close as described in the mechanical specifications. Duct type smoke detectors used in this application shall be of the type that do NOT require a minimum air flow to operate.
- E. Doors:
 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor.
 2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from.

- F. Sprinkler System Interface:
1. Water flow switches, valve position indicator switches for sprinkler service valves, and zone control valves shall be provided under Division 23 of specifications.
 2. Two separate and distinct signals shall be initiated: one indicating movement of the valve from its normal position and the other indicating restoration of the valve to its normal position.
 3. The OFF-NORMAL signal shall be initiated during the first two revolutions of the hand wheel or during one-fifth of the travel distance of the valve control apparatus from its normal position.
 4. The OFF-NORMAL signal shall not be restored at any valve position except normal.
 5. The main sprinkler control valve(s) and each area/zone valve shall be on a separate fire alarm address.
 6. Each flow switch shall be on a separate address. Provide addressable detector bases as previously described.
- G. Post Indicator Valve (PIV) and Backflow Preventer (BFP):
1. Connect the PIV and BFP switches to the fire alarm system.
 2. Provide waterproof flexible conduit from the switch body, through a WP conduit, to rigid conduit. Route the rigid conduit underground and up into the building, into an accessible ceiling plenum. Conduit size underground shall be minimum 3/4" RGC, coated as specified for underground conduits. Provide conduit inside building as required in other sections of this specification.
 3. Provide all required interconnections to building main Fire Alarm Control Panel. Provide addressable interface devices as required for interconnection. Label each addressable device POST INDICATOR VALVE or BACKFLOW PREVENTER as appropriate.
 4. Smoke Detectors for Smoke Dampers:
 - a. Provide duct mounted smoke detectors within 5' (up or down stream) of the smoke dampers shown on the mechanical plans. Interlock this detector with the smoke damper such that activation of the smoke detector closes the damper, shuts down the serving air handler AND sounds the general alarm. Provide relays as required to make this sequence occur.

2.4 COMPONENTS

- A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed by Underwriters Laboratories as suitable for the purpose intended.
- C. Master Control Unit:
1. Control unit construction shall be modular with solid state, microprocessor based electronics. It shall display the controls and displays essential to operation during a fire alarm condition.

2. A local audible device shall sound during Alarm, Trouble, or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel.
3. The following controls shall be visible at the control panel:
 - a. Multi-character liquid crystal display.
 - b. System alarm LED.
 - c. Supervisory service LED.
 - d. Trouble LED.
 - e. "Power on" LED.
 - f. Alarm Acknowledge key/switch.
 - g. Supervisory Acknowledge key/switch.
 - h. Trouble Acknowledge key/switch.
 - i. Alarm Silence key/switch.
 - j. System reset key/switch.
4. The following controls and LED's shall be available at the control panel:
 - a. Manual evacuation (drill).
 - b. Elevator bypass.
 - c. Door holder release bypass.
5. Primary Keys, LED's and LCD Display:
 - a. The Control Panel shall have a multi-character liquid crystal display.
 - b. The Control Panel shall have the capability of handling at least 400 alarm initiation devices.
6. Under normal condition the panel shall display a System is Normal message and the current time and date.
7. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The panel audible signal shall sound for alarm conditions and for trouble and supervisory conditions.
8. The LCD shall display the following information relative to the abnormal condition of a point in the system.
 - a. Specific location label.
 - b. Type of device (i.e. smoke, pull station, waterflow).
 - c. Point status(i.e. alarm, trouble).
9. After all points have been acknowledged, the LEDs shall glow steady and the audible annunciator will be silenced. The total number of alarms, supervisory and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be indicated by an end of list message.
10. When the "Alarm Silence" button is pressed all alarm signals shall cease operation.
11. System Reset:
 - a. The SYSTEM RESET button/switch shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user thru the reset process with simple English language messages where multiple steps are required for reset.
 - b. Should an alarm condition continue to exist a message will be issued and the system will remain in an abnormal state. System control relays shall not reset. The Alarm LED will be on. The display will indicate the total number of alarms and troubles present in system.
12. History Logging: The system shall be capable of logging and storing a minimum of 50 events in an alarm log and 50 events in a trouble log. These events shall be stored in a battery protected random access memory. Each recorded event shall include the time and date of that event's occurrence.

13. Silent Walktest with History Logging:
 - a. The system shall be capable of being tested by one person. While in the testing mode the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm.
 - b. Should the walktest feature be on for an inappropriate amount of time it shall revert to the normal mode automatically.
 14. The fire alarm control unit shall allow for loading and editing operating instructions and sequences.
 15. The control unit shall be capable of onsite programming to accommodate system expansion and facilitate changes in operation.
 16. All software operations shall be stored in a non-volatile programmable memory. Loss of primary and secondary power shall not erase the instructions stored in memory.
 17. The control unit shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.
- D. Remote Annunciators: _____.
1. LCD Annunciators:
 - a. Provide LCD annunciator where shown on plans.
 - b. Annunciator shall identify device initiating alarm or trouble signal.
 - c. Provide alarm and trouble silence switches (and drill switch) in annunciator panel.
- E. Initiating Devices:
1. Manual Pull Stations:
 - a. Manual pull stations shall be addressable. Pull stations shall contain electronics that communicate the station's status (alarm, normal) to the transponder over two wires which also provide power to the pull station. The address shall be set on the station. The station shall mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks.
 - b. The addressable manual station shall be capable of field programming of its "address" location.
 - c. There shall be no limit to the number of stations, detectors or Zone Adapter modules, which may be activated or "in alarm" simultaneously.
 2. Photoelectric Detector Head:
 - a. The photoelectric type detector shall be a plug-in unit which mounts to a twist-lock base, and shall be UL approved.
 - b. The detectors shall be of the solid state photoelectric type and shall contain no radioactive material. They will use a pulsed infrared LED light source and be sealed against rear air flow entry.
 - c. There shall be no limit to the number of detectors which may be activated or "in alarm" simultaneously.
 3. Addressable Photoelectric Duct Detector:
 - a. The detector shall be a non-polarized 24VDC type which is compatible with the Fire Alarm Panel. Provide and install all detectors referenced in Division 23.
 - b. See Photoelectric Detector Head for unit operation. Detector located in air handling unit(s) supplying operating suites within a Health Care Facility shall

- contain auxiliary contacts (SPST, 3 amps, 125 volts minimum. Refer to Instruments and Controls in Division 23 for additional information.
- c. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control panel. Detector design shall provide compatibility with other fire alarm detection loop devices (heat detectors, pull stations, etc.)
 - d. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housings front cover. Install detectors as required by NFPA 90A.
 - e. To minimize false alarms, voltage and RF transient suppression techniques shall be employed as well as an insect screen.
 - f. Provide duct detectors anywhere a smoke control damper is installed. See the mechanical plans.
 - g. The detector shall be of the type that does NOT require minimum air flow to operate.
4. Heat Detectors: Thermal detector heads must be UL listed. They will be a combination rate-of-rise and fixed temperature (135 F) type, automatically restorable.
5. Addressable Detector Bases: All addressable smoke detector heads as specified below will be pluggable into their bases. The base will contain electronics that communicate the detector status (normal, alarm, trouble) to the control panel over two wires. The same two wires shall also provide power to the base and detector. Upon removal of the head, a trouble signal will be transmitted to the control panel.

F. Notification Appliances:

1. Audible and/or Visual Units:
 - a. Audible horn sound level shall be a minimum 90dBA at 10 feet.
 - b. Provide speakers and amplifiers as required for voice evacuation where required. See plans for speaker locations.
 - c. Any two visual strobes placed in the same field of view shall flash in synchronization.
 - d. Note: Strobe lenses may not be lower than 80" AFF. This does not mean the backbox may be at 80", as this would have the strobe lens below 80". Where indicated as "at 80'", this means the bottom of the LENS, strobe lens may be no higher than 96". Strobes may be located higher than 80" AFF if intensity of strobe is increased to the point that effective intensity is the same as a 75 candela strobe placed at 80" AFF. Wall mounted strobes shall still be located minimum 6 inches below ceiling. Contractor shall submit calculations from fire alarm vendor showing no change in effective intensity for strobes mounted higher than 80" AFF.
 - e. Use minimum 75 candela intensity strobes. Strobes shall be xenon type or equivalent.
 - f. Flash rate of strobe shall be in the 1 to 2 Hz. range.
 - g. Maximum pulse duration of strobe shall be 0.2 seconds, with a maximum duty cycle of 40 percent.

G. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

1. Individual conductors shall be numbered utilizing permanently attached markers at all terminations and junction boxes.

2. Detailed wiring diagrams shall be provided showing color coding and numbering of conductors.
- H. Surge Protection: In accordance with IEEE C62.41 B3 combination waveform and NFPA 70; except for optical fiber conductors.
1. Provide surge protection devices at the control panel for all power, signal, and control cables/conductors leaving the control panel.
 2. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 3. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 4. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
 5. In addition to above, provide surge protection for any circuit exceeding 1000 feet in length.
- I. Locks and Keys: Deliver keys to Owner.
- J. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 2. Provide one for each control unit where operations are to be performed.
 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and the contract documents.
- B. All wiring shall be installed in strict compliance with all of the provisions of the NEC Article 760.
- C. All fire alarm conductors shall be installed in EMT out of the wall into an accessible space. Cable must be plenum rated and routed on J hooks to the termination point. The only exception is fire alarm devices in exposed ceilings - no cabling shall be visible in exposed spaces. Use conduit painted to match the other devices in the space.
- D. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- E. Obtain Owner's approval of locations of devices, before installation.
- F. Install instruction cards and labels.

- G. The manufacturer's authorized representative shall provide onsite supervision of installation and shall provide a Certificate prior to the Final Observation certifying proper operation of the system and all devices.
- H. Elevators:
 - 1. Provide relays and contact operations for signaling the elevator controls of initiation of any fire alarm condition and identifying the alarming device.
 - 2. Provide a 1-inch, IMC raceway to the elevator control room.
- I. Where NFPA 101 requires acceptance of "equivalent performance", the contractor shall perform all testing and shall make any changes to gain acceptance by the Georgia State Fire Marshal.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify the State Fire Marshal and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Demonstrate the operation of all components of the Fire Alarm System at the final inspection. There shall be a representative from the fire alarm contractor on site for the final inspection. The Architect shall witness all tests.
- H. The Contractor shall arrange for a worker to remain at the fire alarm control panel for the duration of the test to report status and reset alarms. The Contractor shall arrange for another worker to accompany the Architect to each initiating device and to perform all tests. All items required to test the detectors, such as canned smoke, shall be provided by the Contractor. The Contractor shall also demonstrate that each audible and/or visual strobe is functioning properly.
- I. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.3 PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
 - 2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.

3. Factory Instruction: At control unit manufacturer's training facility.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 1. Initial Training: 1 session pre-closeout.
- D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:
 1. Initial Training: 1 session pre-closeout.
 2. Refresher Training: 1 session post-occupancy.
- E. Maintenance Technicians: Detailed training for electrical technicians, on programming, maintaining, repairing, and modifying; factory training:
 1. Refresher Training: One 1-day session post-occupancy.
- F. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 1. Be prepared to conduct any of the required tests.
 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 4. Demonstration may be combined with inspection and testing required by the State Fire Marshal; notify authority having jurisdiction in time to schedule demonstration.
 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 1. Approved operating and maintenance data has been delivered.
 2. Spare parts, extra materials, and tools have been delivered.
 3. All aspects of operation have been demonstrated to Owner.
 4. Final acceptance of the fire alarm system has been given by the State Fire Marshal.
 5. Specified pre-closeout instruction is complete.

END OF SECTION 28 3100

SECTION 31 1000

SITE CLEARING

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Provide to the Owner one reproducible transparency and two blue/black line as-built record prints of all underground utilities installed or encountered.

1.02 PROJECT CONDITIONS

- A. Verify existing grades prior to beginning site preparation. If existing grades are at variance with drawings, notify Owner and receive instructions prior to proceeding.
- B. Existing utilities are indicated on the drawings at approximate locations and reflect general observation from ground surface. Notify Owner and coordinate exact location of utilities prior to beginning site preparation.
- C. Protect active utilities and remove or relocate as shown on the drawings. Remove or relocate active utilities encountered but not shown on drawings in accord with Owner's written instructions.
- D. Plug or cap inactive utilities encountered, not less than 5'-0" outside building lines.
- E. Identify and protect utilities for duration of project.

1.03 QUALITY ASSURANCE

Not Applicable

1.04 WARRANTY

Not Applicable

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 SITE CLEARING AND GRUBBING

- A. General: Remove vegetation, improvements, or obstructions interfering with installation of new construction and grading.
 - 1. Completely remove and dispose of all trees, stumps, roots and other debris protruding through the ground except for those indicated to be left standing or in areas beyond the indicated limits of work.
 - 2. Grubbing operations shall remove all roots larger than 1-1/2 inches in diameter and longer than 3 feet.

- B. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4". Satisfactory topsoil shall be free of subsoil, clay lumps, stones, and other objects over 2" in diameter, and without weeds or roots.
 - 1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil.
 - 2. Remove heavy growths of grass from areas before stripping.
 - 3. Stockpile topsoil in storage piles. Construct storage piles to drain surface water.

- C. Fill depressions caused by clearing and grubbing operations with soil material, unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not to exceed 6" loose depth, and thoroughly compact to a density equal to adjacent original ground.

3.02 DISPOSAL OF WASTE MATERIAL

- A. All material resulting from the clearing and grubbing operations shall become the property of the Contractor and he shall dispose of it as he wishes except that he shall comply with regulations of Gwinnett County.

- B. Burning shall not be permitted.

- C. Tree stumps shall become the property of the Contractor and shall be removed from the site.

- D. Bury pits shall not be permitted.

END OF SECTION 31 1000

SECTION 31 2300
EXCAVATION AND FILL

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Test Reports: Submit two copies, minimum, of the following reports directly to the Architect from the testing service. The Architect will retain two copies:
 - 1. Test reports on borrow material.
 - 2. Verification of each footing subgrade.
 - 3. Field density test reports.
 - 4. Verification of classification of soil type used in fill and backfill.
 - 5. One optimum moisture-maximum density curve for each type of soil encountered.
 - 6. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.

1.02 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Architect and then only after acceptable temporary utility services have been provided.
 - a. Provide minimum of 48-hour notice to Owner, and receive written notice to proceed before interrupting any utility.
 - 3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.
 - 4. All trench excavations resulting from removal of utility lines shall be backfilled with engineered fill.
- B. Use of Explosives: The use of explosives is not permitted.
- C. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.
 - 1. Operate warning lights as recommended by authorities having jurisdiction.

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2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
- D. Graded Areas: Any settlement or washing that occurs during and until completion of project and prior to acceptance of the work shall be repaired immediately and grades reestablished to the required elevations and slopes. Fill to required subgrade levels any areas where settlement occurs.
- E. Temporary Grading and Drainage: Provide effective drainage at all times. No impoundment of water shall be permitted except as provided. Pools, puddles or inundated excavations shall be drained immediately. The Contractor is fully responsible for any and all water damage within the Limit of Work and all water damage to the site or installed work.

1.03 QUALITY ASSURANCE

- A. Engineering: Layout work shall be done under the supervision of an engineer or land surveyor, registered in the State of Georgia, familiar with construction layout work, at no additional cost to the Owner.
- B. Maintain carefully all bench marks, monuments and other reference points. If disturbed or destroyed, replace. If found at variance with Drawings, notify Owner before proceeding to layout work.
- C. Codes and Standards: Perform excavation work in compliance with applicable requirements of Standard Building Code (International Building Code) 2000 Edition with Georgia Amendments.
- D. Testing and Inspection Service: Owner will engage soil testing and inspection service for quality control testing during earthwork operations.
- E. Testing Requirements:
 1. Compaction tests in accord with ASTM D698-78.
 2. Field density tests for area fills for each 1'-0" lift, in accord with ASTM D698-78, one test for each 5,000 sq. ft. of fill.
 3. Field density tests for trench excavations for each 1'-0" lift, in accord with ASTM D698-78, one test for each 100 linear feet of trench under buildings and pavement, one test for each 200 linear feet otherwise.
 4. Inspection and testing subgrades and proposed fill materials.
 5. Inspection of excavation bracing system, including furnishing, installing and monitoring slope indicator devices and settlement gauges.
 6. Contractor's duties relative to testing include:
 - a. Provide representative fill soil samples to Testing Agency for test purposes. Provide 50 lb. samples of each fill soil.

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- b. Advise Testing Agency sufficiently in advance of operations to allow for completion of quality tests and for assignment of personnel.
- c. Be responsible for paying costs of additional testing if initial tests reveal nonconformance with specified requirements.

F. Obtain and become familiar with the Geotechnical Exploration Report.

1.03 WARRANTY

Not Applicable

PART 2 - PRODUCTS

2.01 MATERIALS

A. Definitions:

1. Satisfactory soil materials are defined as those with no organics, a plasticity index of less than 20 and a maximum particle size of four inches, with not more than 30% greater than 3/4 inch. It shall be clean material and rock no larger than 1/2 cu. ft. Fill material shall be tested and approved by Testing Agency for degree of compaction required by its intended use.
2. Unsatisfactory soil materials are defined as those complying with ASTM D 2487-83 soil classification groups OH and PT or soil materials not capable of being compacted to density and moisture requirements of this section, debris, organic material and soil containing organic material.

2.02 POROUS FILL

- A. Crushed stone or gravel meeting ASTM C33-86, size 57.

PART 3 - EXECUTION

3.1 LAYOUT

- A. Before the work is started, stake out the base lines of work and establish bench marks and reference points.
- B. Protect all grade stakes during the grading and filling operations, and reset any grade stakes and line stakes destroyed.
- C. Verify all bench marks and protect same during construction.
- D. Verify and flag all property corners and bench marks within 50 feet of any clearing or grading operations.

3.02 EXCAVATION

- A. Excavation Classifications: The following classifications of excavation will be made when rock excavation is encountered in work.
1. Earth Excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
 2. Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered occupying an original volume of more than ½ cubic yard which cannot be excavated with a backhoe having a bucket curling force rated at not less than 40,000 lbs., using a rock bucket and rock teeth (John Deere 790 or larger). Trenches in excess of 10'-0" in width and pits in excess of 30'-0" in either length or width are classified as open excavation.
 3. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered occupying an original volume of more than 1 cubic yard which cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a minimum draw bar pull rating of not less than 80,000 lbs., usable pull (Caterpillar D-8 or larger).
 - a. Typical of materials classified as rock are solid rock, rock in ledges, and rock-hard continuous aggregate deposits.
 - b. Intermittent drilling or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
 - c. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by Owner. Such excavation will be paid on basis of contract conditions relative to changes in work.
- B. Rock payment lines are limited to the following:
1. Two feet outside of concrete work for which forms are required, except footings.
 2. One foot outside perimeter of footings.
 3. In pipe trenches, 6" below invert elevation of pipe and 2 ft. wider than inside diameter of pipe, but not less than 3 ft. minimum trench width.
 4. At outside dimensions of concrete work where no forms are required.
 5. Under slabs on grade, 6" below bottom of concrete slab.
- C. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owner. Unauthorized excavation, as well as remedial work directed by Owner, will be at Contractor's expense.
1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be acceptable if approved by Owner.

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2. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Owner.
- D. Additional Excavation: When excavation has reached required subgrade elevations, notify Owner, who will make an inspection of conditions.
1. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by Owner.
 2. Where it is not possible to provide a safe embankment slope, banks shall be temporarily supported and maintained secure until permanent support has been provided.
 3. Where ditches or trenches are over 5'-0" deep, cross bracing and shoring shall be provided to prevent collapse.
 4. Provide bracing systems designed by an engineer registered in the State of Georgia, experienced in bracing design. Submit reproducible shop drawings, showing the work and sequence in its entirety, to the Architect prior to commencing the work.
 5. To prevent cave-in, or settlement of earth adjacent to excavations, and for protection of persons as well as property, shoring, bracing and other similar work will be provided and installed to meet the conditions in each particular case and will be left in place until construction has reached a point where backfills behind walls or in ditches has been made and the need for shoring and bracing eliminated.
- E. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
- F. Material Storage: Stockpile satisfactory excavated materials, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
 2. Dispose of excess soil material and waste materials as herein specified.
- G. Excavation for Pavements: Cut surface under pavements to comply with cross-sections, elevations and grades as shown.

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- H. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe or conduit.
1. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevation. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.
 2. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
 3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 4. Backfill trenches with concrete where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.
 5. Do not backfill trenches until tests and inspections have been made and backfilling authorized by Owner. Use care in backfilling to avoid damage or displacement of pipe systems.

3.03 FILL AND BACKFILL

- A. Provide satisfactory soil material to perform earthwork operations indicated, including filling and backfilling to bring grade to elevations indicated. The cost of additional fill material required as a result of removal of existing unsuitable soil material will be included in the Contract.
- B. Soils used as fill underneath the building structure shall be select fill as approved by the Testing Agency.
- C. Preparation of surfaces to receive fill:
1. Remove vegetation, unsuitable soil materials, obstructions and deleterious materials from ground surface prior to placement of fills. Break up sloped surfaces steeper than one vertical to four horizontal so that fill material will bond with existing surface.
 2. Proofroll subgrades prior to placing fill using loaded 14 cubic yard, triaxle dump truck or similar weight construction equipment. Proofroll only under the surveillance of the Testing Agency. All soft areas revealed by the proofrolling shall be under cut, stabilized and filled as directed by the Testing Agency.
 3. When existing ground surface has density less than specified for particular area classification, break up the ground surface, pulverize, or moisten or aerate to provide the optimum moisture content, and compact to required depth and percentage of maximum density.
- D. Placement and Compaction: Place fill materials in layers not more than 8" in loose depth. Place no rocks exceeding 3" in diameter in top 1'-0" of fill. Before compaction, moisten or aerate each layer to provide the optimum moisture content. Compact each

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layer to specified percentage of maximum density for area classification. Place no back fill or fill material on surfaces that are muddy, frozen or contain frost or ice.

- E. Bed pipe in trenches on continuous soil foundation shaped to lowest one-fourth of pipe profile. Form depressions for hubs and similar joints as required.
- F. Backfill against pipe in layers of not more than 6" loose depth. Place backfill evenly along both sides of pipe to level of top of piping. Compact each layer with power tampers. Place no rock exceeding 3" diameter in first 1'-0" of fill directly over top of piping.
- G. Where trench excavation extends into wet unstable soil conditions, provide #57 crushed granite to stabilize the trench bottom and backfill the pipe to a depth of 4" above the top of the pipe.

3.04 COMPACTION (CONTROLLED STRUCTURAL FILL)

- A. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification as indicated below.
- B. Do not place fill upon muddy or frozen surfaces. No snow, ice or frozen material is to be incorporated into the fill.
- C. Percentage of Maximum Density Requirements: Compact soil in layers of loose material to not less than the following percentages of maximum dry density by the Standard Proctor Test, ASTM D 698-78.
 - 1. Structures, Building Slabs and Steps: Compact subgrade and each layer of backfill or fill material at 95% maximum dry density. Compact the top two feet to at least 98% maximum dry density.
 - 2. Walkways: Compact subgrade and each layer of backfill or fill material at 95% maximum dry density. Compact the top two feet to at least 98% maximum dry density.
 - 3. Pavements: Compact subgrade and each layer of backfill or fill material at 95% maximum dry density. Compact the top two feet to at least 98% maximum dry density.
- D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
 - 1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - 2. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by disking, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

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3. Perform moisture density determinations for each soil type used, to provide data for quality control. The natural moisture content at the time of compaction must be within moisture content limits that will allow the specified compaction to be obtained, but not in excess of 3% above or below the optimum moisture content.

3.05 COMPACTION (NON-STRUCTURAL FILL)

- A. Perform compaction of soil materials for fills using mechanical soil compaction equipment for type and size materials to be compacted. Hand compact materials in areas inaccessible to machinery and within 5'-0" of below grade walls.
- B. Percentage of Maximum Density Requirements: Provide not less than the following percentages of maximum dry density by the Standard Proctor test, ASTM D698-78.
 1. Lawn or Unpaved Areas: Compact top 6" of subgrade & each layer of backfill or fill material at 90% maximum dry density.
- C. Moisture Control: Where subgrade or soil layer must be moisture conditioned before compaction, apply water to surface of subgrade or soil layer. Scarify and air dry soil material that is too wet to permit compaction to specified density. Control soil moisture content of in place fill to within 3% of optimum moisture content.
- D. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread where directed by Owner and permitted to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to satisfactory value, as determined by moisture density relation tests. When accepted by Testing Agency, soil material may be used in compacted backfill or fill.

3.06 ROUGH GRADING

- A. Grade areas to lines and elevations indicated, including adjacent transition area. Smooth finished surface within specified tolerances, compact and bring to uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Finish surfaces will be free from irregular surface changes, and as follows:
 1. Surfaces under walks and pavements: Shape surface of areas to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.
 2. Surfaces under building slabs: Grade level, free of oils, compacted as specified, and within 1/2" of required elevation.
 3. Grassed areas: Shape areas to receive topsoil to within 0.10' above or below required subgrade elevation.
 4. Compaction: After grading, compact subgrade surfaces to depth and percentage of maximum density specified.

3.07 FINISH GRADING

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- A. Finish grade entire site obtaining uniform levels or slopes between points where elevations are shown or between such points and existing grades.
- B. Grade areas adjacent to building lines to drain away from building and to prevent ponding. Finish grades are to be within 1/4" of indicated elevations.
- C. Where cut and fill areas are disturbed by construction operations, scarify surface, reshape and recompact to required density.
- D. Redistribute stockpiled topsoil to uniform depth over graded areas.
- E. Remove excess topsoil, subsoil from footing excavations, and other excess soil matter and debris from the site.
- F. At completion of finish grading operation, entire site is to be ready for landscaping.
- G. Where finish grading meets or abuts curbs, walks or pavements, uphill grades are to be slightly higher than pavements to permit drainage.
- H. Protection of graded areas: Protect newly graded surfaces from traffic and erosion. Keep free of debris. Where graded or compacted surfaces are damaged by subsequent operations, return to indicated grade and state of compaction.

END OF SECTION 31 2300

SECTION 31 2500

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Schedule of Operations: Submit minimum two copies schedule of proposed operations including program for erosion control measures, maintenance of control facilities and vegetative practices. Show anticipated starting and completion dates for land-disturbing activities including excavation, filling and rough grading, finish grading, construction of temporary and permanent control measures, and disposition of temporary sediment control measures.
- B. Submit minimum two copies manufacturer's technical product data and installation instructions for silt fence, matting blankets, and other erosion control products.
- C. Submit minimum two copies supplier's information on seed and/or hydroseed mixtures including rate of application and recommended application dates.

1.02 PROJECT CONDITIONS

- A. Schedule erosion control construction prior to any grading or utility installation.
- B. Schedule grading operations to allow paving and permanent erosion control to take place in the same construction season, if possible. Avoid or minimize exposure of soils to winter weather.
- C. Construct and maintain temporary erosion control measures until such time as permanent paving, planting and restoration of natural areas is effective. Contractor will provide erosion control measures in addition to those specified based on conditions at the project site at no additional cost.
- D. Protect adjacent and downstream properties from siltation resulting from erosion of graded areas.

1.03 QUALITY CRITERIA

- A. Applicable Standards:
 - 1. "Manual for Erosion and Sediment Control in Georgia", Fifth Edition, 2000.
 - 2. American Society for Testing and Materials (ASTM), standards as referenced herein.
 - 3. Georgia Seed Laws and Rules and Regulations.

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4. Georgia Department of Transportation, "Standard Specifications Construction of Transportation Systems ", 2001 Edition, hereinafter referred to as Georgia D.O.T.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Fertilizer:
 1. Regular type: Nitrogen content derived from organic or inorganic sources; bearing manufacturer's statement of analysis. Minimum requirements: 5% nitrogen, 10% phosphoric acid, 15% potash.
 2. Slow-release type: 50% of nitrogen is in slow-release form, content derived from organic or inorganic sources; bearing manufacturer's statement of analysis. Minimum requirements: 10% nitrogen, 10% phosphoric acid, 10% potash.
- B. Annual Rye (*Lolium Multiflorum*) seed: Fresh, clean seed testing 90% minimum purity, 70% minimum germination, 1% maximum weed content.
- C. Bermuda (*Cynodon Dactylon*) seed: Fresh, clean, hulled, new seed crop; 90% minimum purity, 70% minimum germination, 1% maximum weed content.
- D. Straw bales: Clean bales of straw of hay, wheat, rye, oats or barley.
- E. Hydromulch: Wood cellulose fiber containing no germination inhibiting or growth inhibiting agents. Characteristics shall be as follows:
 1. Percent moisture content: 9.0% (+/- 3.0%)
 2. Percent organic matter: 90.2% (+/- 0.8%)
 3. Percent ash content: 0.8% (+/- 0.2%)
 4. pH: 4.8 (+/- 0.5%)
 5. Water holding capacity: 1150 grams water/100 grams fiber, minimum.
- F. Mulch: Clean, debris free, pine straw, free of all sticks and foreign material.
- G. Asphalt emulsion: Meeting ASTM D977, Grade SS1.
- H. Staking pegs: 3/4" diameter by 8" long softwood.
- I. Water: Clean, potable.
- J. Coarse aggregate: Meeting Georgia D.O.T. Specifications, Section 603 for plain rip-rap.
- K. Filter Fabric: Meeting Georgia D.O.T. Specifications, Section 171, Temporary Silt Fence.

PART 3 - EXECUTION

3.01 TEMPORARY EROSION CONTROL DEVICES

- A. Construct temporary sediment barriers at all points where surface water flows from construction area, including entire perimeter of construction area where slope is outward and at other locations specified hereinafter.
 - 1. Construct barriers of silt fencing per Georgia D.O.T. Specifications.
 - 2. Arrange barriers to create ponding. Remove accumulated sediments at intervals as required to maintain original ponding capacity.
 - 3. Maintain temporary barriers until permanent erosion control measures are established. Repair and replace barriers damaged or displaced by construction activity.

3.02 EROSION CONTROL DURING GRADING OPERATIONS

- A. Schedule grading operations to minimize exposure of graded surfaces prior to installation of permanent construction.
- B. Stockpile and compact excavated materials to be reused. Remove excess materials from project site.
- C. Maintain large areas as flat as possible to minimize runoff. Where slopes of one vertical to four horizontal or steeper are indicated, construct a temporary sediment barrier at top of slope to cause water to flow to a controlled slope drain. In no case shall surface water be allowed to flow uncontrolled down graded slopes.
- D. Slope drains: Provide temporary drains to convey surface water down slopes. Provide drains with a top apron to anchor drain and to direct water. Place stone rip-rap at drain outlets in minimum 6" thickness to prevent scour.

3.03 STORM DRAINAGE SYSTEM

- A. Maintain temporary sediment barriers around drainage structures until final subgrade preparation is begun to prevent washing of sediment into storm drainage system.
- B. Flush drainage lines between manholes and drainage structures as required during construction and after establishment of permanent erosion control measures to remove collected debris.

3.04 GROUND COVER

- A. Protect exposed soils having a slope of five percent or greater with ground cover.

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- B. Ground cover may consist of any effective erosion preventive treatment such as straw mulch, stone base, plastic sheeting, hydroseeding or installation of permanent grassing or planting, as applicable.
- C. All grassing or planting operations will include mulching as stabilization until ground cover by planting is effective.

3.05 HYDROSEEDING

- A. Apply seed/fertilizer/hydromulch mixture in water slurry. Dispense using hydraulic mulching equipment in following minimum quantities:
 - 1. Fertilizer: 120 lbs./acre
 - 2. Tall Fescue: 70 lbs./acre
 - 3. Hydromulch: 1200 -1500 lbs./acre
- B. Seed in accordance with the following schedule:
 - 1. Tall Fescue: August 15 – October 31
 - 2. Bermuda: March 15 – June 30 (hulled), October 1 – February 28 (unhulled)
 - 3. Annual Rye: August 15 – March 31

3.06 REMOVAL OF TEMPORARY EROSION CONTROL DEVICES

- A. As soon as permanent erosion control devices are established, Contractor may remove temporary devices, including sediment barriers, berms, slope drains and similar devices.
- B. Remove all debris from project site.

END OF SECTION 31 2500

SECTION 32 1200
FLEXIBLE PAVING

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Certificates: Submit a minimum of two certificates stating that materials supplied comply with specifications. Certificates shall be signed by asphalt producer and contractor.
- B. Mix Design: Submit two copies, minimum, of mix design for base and surface paving courses to the Owner for approval.
- C. Product Data: Submit two copies, minimum, of product data for traffic marking paint.

1.02 PROJECT CONDITIONS

- A. Weather Limitations:
 - 1. Apply bituminous prime coat only when the ambient temperature in the shade is above 50 degrees F. for 12 hours immediately prior to application.
 - 2. Do not apply when surface is wet or contains excess of moisture which would prevent uniform distribution and required penetration.
 - 3. Construct asphaltic courses only when atmospheric temperature is above 40 degrees F., when the underlying base is dry and when weather is not rainy.
 - 4. Place base course when air temperature is above 35 degrees F. and rising.
- B. Grade Control: Establish and maintain the required lines and grades for each course during construction operations.
- C. Traffic Control:
 - 1. Maintain vehicular and pedestrian traffic during paving operations, as required for other construction activities.
 - 2. Provide flagmen, barricades, warning signs and warning lights for movement of traffic and safety and to cause the least interruption of work.

1.03 QUALITY ASSURANCE

- A. Industry Standards: Georgia D.O.T. Standard Specifications, Construction of Transportation Systems, 2001.
- B. Allowable variation in thickness:
 - 1. Base course: +/- 1/2".
 - 2. Intermediate course: +/- 1/4"

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3. Surface course: +/- 1/8"

C. TESTING

1. Owner will retain Testing & Inspection Laboratory.
2. Testing laboratory will test in-place courses for compliance with specified density, thickness and surface smoothness requirements.
3. Laboratory will take two 4" diameter cores per 1,000 sq. yds. at locations selected by the Owner for density and thickness tests. Cores shall be taken through base, intermediate and/or surface course. Repair holes resulting from coring to match existing paving.
4. Density: Compare density of in-place material against laboratory specimen of same mixture, subjected to 50 blows of a Standard Marshall Hammer on each side of specimen. Minimum acceptable density of in-place material to be 97% of recorded laboratory specimen density.
5. Contractor's duties relative to testing include:
 - a. Notify laboratory of conditions requiring testing.
 - b. Coordinate with laboratory for field testing.
 - c. Assume payment for additional testing performed beyond scope of that required and for retesting where initial tests reveal nonconformance with specified requirements.

PART 2 - PRODUCTS

2.01 PAVING MATERIALS

- A. Graded Aggregate: Meeting Georgia D.O.T. Specifications, Section 815.
- B. Surface Course: Meeting Georgia D.O.T. Specifications, Section 828.2.03, for 9.5 mm Superpave Level B (F.K.A. Type "F") Hot Mix Asphaltic Concrete.
- C. Intermediate Course: Meeting Georgia D.O.T. Specifications, Section 828.2.03, for 19 mm Superpave (F.K.A. Type "B") Hot Mix Asphaltic Concrete.

2.02 MARKING PAINT

- A. Traffic Lane Marking Paint: Meeting Georgia D.O.T. Specifications, Section 870.2.02.A.2, for Waterborne White Traffic Line Paint.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

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- A. Prior to beginning paving work, inspect subgrade for loose or soft material, rock or organic matter. No stones over 2" in diameter will be allowed in top of 6" of subgrade.
- B. Proofroll subgrade using heavy rubber tired vehicle to verify that exposed subgrades are stable and to identify loose or soft areas requiring undercutting or stabilization. Proofrolling to be performed under surveillance of Testing Agency.
- C. Stabilization of soft or unstable subgrades is to be accomplished to minimum depth of 6". Stabilization aggregate is to be of type specified for base course aggregate.
- D. Verify proper elevations and cross sections of subgrade immediately prior to placing base material.

3.02 PLACING ASPHALT PAVING

- A. Base: Graded aggregate.
- B. Intermediate Course: 19 mm Superpave Hot Mix.
- C. Asphaltic Surface Course: 9.5 mm Superpave Level B Hot Mix Asphaltic Concrete.
- D. Place and spread aggregate base material to compacted depth indicated, to elevation and shape. Compact base course to dry density of 98% in accord with ASTM D 1557.
- E. Apply prime coat after base course has been compacted and brought to grade. Select material and proper application temperature as specified in Georgia D.O.T. Specification, Section 412.
- F. Following application and curing of prime coat, apply intermediate course in minimum compacted thickness indicated.
- G. Intermediate course must be free of dust, soil and debris. Apply tack coat immediately prior to surface course application. Tack coat material and application procedures are to comply with Georgia D.O.T. Specifications, Section 413.
- H. Apply asphaltic surface course in minimum compacted thickness indicated.
- I. Mix, transport and place asphalt in accord with Georgia D.O.T. Specifications.
- J. Place asphalt at proper temperature and compact to at least 95% of laboratory density as specified in ASTM D 1559. While hot, compact mixture by rolling. Asphalt temperature at time of application is to be in conformance with Georgia D.O.T. Specifications, Sections 400 and 424.

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3.03 MARKING ASPHALT PAVEMENT

- A. Cleaning: Sweep surface with power broom supplemented by hand brooms to remove loose material and dirt.
- B. Apply paint with mechanical equipment in uniform straight lines. Apply in accord with manufacturer's recommended rates.

3.04 CLEANING AND PROTECTION

- A. At completion of each operation, remove excess or spilled materials from site. Dumping or spreading of excess asphalt materials on project site is prohibited.
- B. After placement of surface course, vehicular or pedestrian traffic on pavement is prohibited until it has cooled and hardened for a minimum period of 24 hours.

END OF SECTION 32 12 00

SECTION 32 1300

RIGID PAVING

PART 1 - GENERAL

1.01 SUBMITTALS

Not Applicable

1.02 PROJECT CONDITIONS

Provide welded wire mesh reinforced Portland cement concrete pavement.

Scheduling and Sequencing: Schedule site improvement work of other trades required to be installed prior to execution of this work.

1.03 QUALITY ASSURANCE

- A. Applicable standards: Standards of the following, as referenced herein:
1. American Concrete Institute (ACI).
 2. American Society for Testing and Materials (ASTM).
 3. American Wood Preservers Association (AWPA).

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Forms: Steel, wood, or other suitable materials of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.
1. Use flexible spring steel forms or laminated boards to form radius bends as required.
 2. Coat forms with a non-straining form release agent that will not discolor or deface surface of concrete.
- B. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185-79.
- C. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 40.
- D. Concrete Materials: 3000 psi having 1" maximum coarse aggregate. 4" maximum slump and 3% minimum air entrainment unless otherwise noted on plans.
- E. Expansion Joint Materials: Non-extruding type cane fiber bound and impregnated with bituminous material.

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2.02 CONCRETE MIX, DESIGN AND TESTING

- A. Comply with requirements of applicable Division 03 sections for concrete mix design, sampling and testing, and quality control, and as herein specified.
- B. Design mix to produce normal-weight concrete consisting of portland cement, aggregate, air-entraining admixture and water to produce the properties enumerated in 2.1.D., above.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

- A. Prepare subgrade as specified in Earthwork section, to uniform grade and density.
- B. Compact top 12" to 98% maximum dry density.
- C. Remove loose material from compacted subbase surface immediately before placing concrete.
- D. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
- E. Moisten subgrade just prior to concrete placement. Place no concrete on subgrades which are saturated or which contain standing water.

3.02 FORM CONSTRUCTION

- A. Set forms to required grades and lines, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.
 - 1. Check completed formwork for grade and alignment to following tolerances:
 - a. Top of forms not more than 1/8" in 10'
 - b. Vertical face on longitudinal axis, not more than 1/4" in 10'
 - c. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

3.03 REINFORCEMENT

- A. Locate, place and support reinforcement as specified in Division 3 sections, unless otherwise indicated.

3.04 CONCRETE PLACEMENT

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- A. Comply with requirements of Division 03 sections for mixing and placing concrete, and as herein specified.
- B. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide 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.
- C. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint device.
- D. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place a construction joint.
- E. When adjacent pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained sufficient strength to carry loads without injury.

3.05 CONCRETE WALKS, STEPS AND NON-VEHICULAR PAVEMENTS

- A. Slope walks, step treads and pavements to a minimum of 1/16" per foot to prevent puddling or ponding of water.
- B. Joints:
 - 1. Provide expansion joints to isolate pavement from permanent construction abutting or within paved areas, including joints between pavement and curbing, steps, walls and drainage structures. Align joints with drainage structures and changes in dimension or type of pavement. Align joints between adjacent pavement and curbs.
 - 2. Form pavement control joints and expansion joints to patterns indicated. Control joints shall penetrate 1/4 of thickness of pavement.
 - 3. Form expansion joints at intersection of pavement with building walls with filler strip placed 1/2" below top of concrete and seal joint as specified in Sealants and Caulkings section.
- C. Tool edges and joints of walks and pavements after finishing to 1/4" radius with 1-1/2" wide smooth border or as indicated on the drawings.
- D. Non-slip broom finish: Immediately after trowel finishing, roughen concrete surface by brooming in direction perpendicular to main traffic route. Coordinate required final finish with Owner before application. Apply non-slip broom finish to exterior concrete walks, pavements, platforms, ramps and steps.
- E. Rubbed finish: After removal of forms and before concrete has cured rub exposed surfaces and ease sharp corners or edges with carborundum stone and water to

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achieve a smooth finish of uniform color and texture. Do not use slush coat of cement grout or cement wash at any stage of this finish. Apply rubbed finish to exposed surfaces or step structures, retaining walls and other formed site concrete, except as otherwise specified.

END OF SECTION 32 1300

SECTION 32 1600
CURBS AND GUTTER

PART 1 - GENERAL

1.01 SUBMITTALS

Not Applicable

1.02 PROJECT CONDITIONS

A. Provide concrete curbs and gutters.

1.03 QUALITY ASSURANCE

A. Applicable Standards:

1. American Society for Testing & Materials (ASTM).
2. American Concrete Institute (ACI).

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete: 3000 psi.

B. Expansion Joint Material: Non extruding type cane fiber bound and impregnated with bituminous material.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Prepare subgrade as specified in Section 31 23 00 -Earthwork, to uniform grade and density.

B. Moisten subgrade just prior to concrete placement. Place no concrete on subgrades which are saturated or which contain standing water.

3.02 INSTALLATION

A. Form curb to line and grades indicated.

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- B. Form in lengths not to exceed 12'-0", for straight sections, 4'-0" for curved sections with expansion joints at 48'-0" intervals.
- C. Curb may be placed using automatic curb machine. Saw control joints as soon as concrete has attained initial set.
- D. Form curb to straight lines and true arises. Formwork shall hold weight of wet concrete without deflection. Lay out radii with curved steel formwork. Clean formwork prior to re-use.
- E. Provide uniform radius at curb face and light brushed finish in accord with AC1-301-72.

END OF SECTION 32 1600

SECTION 32 3113
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Submit two copies, minimum, product data from manufacturer, including size and weight of posts and gage of fence fabric.

1.02 PROJECT CONDITIONS

- A. Provide chain-link fence including excavation, concrete, materials herein specified and any other incidental items of the types and sizes and at the locations shown on the plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Material for Framework: Steel conforming to the applicable requirements of the latest ASTM Standard Specifications, Serial Designation A 36 for Structural Steel.
- B. End, Corner, Angle and Pull Posts: 2-7/8 inch outside diameter, standard tubular steel weighing not less than 5.79 pounds per linear foot.
- C. Line Posts: 2-1/4 inch structural "H" sections weighing 3.65 pounds per linear foot or 2-3/8 inch outside diameter steel pipe weighing 4.10 pounds per linear foot.
- D. Top and Bottom Rails: 1-5/8 inch outside diameter steel pipe weighing 2.27 pounds per linear foot. Provide with expansion rail couplings spaced at not less than 20-foot intervals.
- E. Gate Posts for Vehicular Gates: 4-inch outside diameter pipe weighing 9.11 pounds per linear foot.
- F. Braces: Provide at all corners and wherever fabric is not continuous, such as at gates or at other openings. Braces are to be of the same material as top rail.
- G. Chain-link Fabric: Copper-bearing base metal No. 9 gage wire with 1.2 oz. per sq. ft. zinc galvanized, and/or black, brown or green vinyl coated by hot-dip process after weaving. The fabric is to be woven in a 2-inch chain-link diamond mesh with a knuckled selvage along the top rail and a twisted and barbed selvage at the bottom. The barbing is to be done by cutting the wire on a bias, creating sharp points.
- H. Provide a 2-inch padlock and chain with each gate. Three keys are to be furnished with each padlock.

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- I. Gate Frames: 1.9-inch outside diameter pipe weighing 2.72 pounds per linear foot. Corner fittings are to be of heavy, malleable iron castings or pressed steel. Fabric is to be same as in fence. Each gate frame is to be equipped with 3/8-inch diameter adjustable truss rod. Gates are to be complete with ball-and-socket hinges, catch and stops. Hinges are to provide for swinging the gate open through an arc of not less than 180 degrees. Gates must be suitably braced and reinforced to prevent sagging.
- J. All materials entering into the construction of required fencing are to be heavily galvanized and/or vinyl coated by the hot-dip process.

PART 3 - EXECUTION

3.01 ERECTION

- A. Set, corner and gate posts in concrete base not less than 18 inches in diameter which extends at least three inches below the bottom of the post. The post is to extend to a depth of at least three feet below the surface of the ground. A brace is to be spaced midway in height of each end, corner and gate post and extended to the first line post. Braces are to be securely fastened to posts by means of malleable iron connections and trussed from line post back to end corner or gate post with a 3/8 inch diameter rod.
- B. Set line posts are to set in concrete bases not less than 12 inches in diameter extending at least three inches below the bottom of the post. The post is to extend to a depth of at least 30 inches below the surface of the ground. Line posts are to be equally spaced along the line of fence at not to exceed ten-foot intervals.
- C. Provide top rail between line posts. Do not erect fabric until concrete has had sufficient time to cure. Stretch chain-link fabric to uniform tightness on the outside of the posts with suitable tools and fasten with No. 6 gage galvanized wire clips securely clinched and fastened by means of adjustable clamps. Fasten fabric to line posts at 14-inch intervals. Fasten fabric to rail at 24-inch intervals by tie wires.
- D. If a bottom rail is not required, a No. 7 coil spring galvanized wire is to be stretched along the bottom of the fence and securely fastened to the posts. Fasten the chain-link fabric shall be fastened to the tension wire at intervals not to exceed two feet.

END OF SECTION 32 3113

SECTION 32 9100

PLANTING IRRIGATION

PART 1 – GENERAL

1.01 SUBMITTALS

- A. Product Data: Submit a minimum of two copies of data for each type of piping, valves, heads and accessory material. Indicate product descriptions and installation procedures. Include detailed controller description and catalog cuts on standard items.
- B. Substitution of Materials: No substitutions will be considered during the bid process. After the bid is awarded, use of materials differing in quality, size or performance from those specified will only be considered in cases of extreme hardship and upon written approval of the Owner. To make a substitution for specified sprinklers, the Contractor must submit a minimum of two copies to the Owner the manufacturer's catalog sheet showing full specifications of each type sprinkler proposed as a substitute, including discharge of GPM, minimum allowable operating pressure at sprinkler, maximum allowable spacing and distance of throw (coverage). Owner's decision will be based on comparative ability of material or article to perform properly as specified by the design.
- C. Operating and Maintenance Instructions: Submit two copies, minimum, operating and maintenance instructions for entire system. Include programming data for controllers. Include winterization procedures. Include schedule of valve open times to produce a one-inch per week precipitation level. Include wiring diagrams for electrical components. Include full name, address, and telephone number of installer.
- D. As-Built Drawings: At completion of installation, provide one set of reproducible drawings and two sets of blue/black line drawings showing important elements of the irrigation system. Main line and wire locations must be shown on the plan. All valve boxes, backflow devices, drains, isolation valves, etc. must be dimensioned from fixed reference points. Clearly note all approved design changes, pipe size, head locations, etc. NOTE: All paper work described in this section is a requirement for Full Acceptance.

1.02 PROJECT CONDITIONS

- A. Examination of Site: Examine site and related work prior to beginning work and report any unsuitable conditions to Owner. Failure to report unsuitable conditions to Owner constitutes acceptance of these conditions and any resulting additional work caused by these conditions will be done at no additional cost to the Owner.

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- B. Verify existing water pressure and volume prior to commencing work and notify the Owner if existing conditions do not meet the minimum design standards noted on the drawings.
- C. Verification of Specifications: Report in writing to the Owner any deviations between Drawings, Specifications, and the site. Failure to do so prior to installation may necessitate adjustments or corrections at no additional cost to the Owner.
- D. Utilities: The exact location of existing utilities, structures and underground utilities may differ from those indicated on the drawings; confirm exact locations. Contact utilities location service and obtain a verification number. All trenching must be done in a manner to prevent interruption of all utility service. Repair or replace damaged utilities at no additional cost to the Owner.
- E. Utility Interruption: Where work requires interruption of existing public utility service, obtain written permission from affected utility company for interruption. Coordinate any such interruptions with affected utility company. Where work requires interruption of Owner's existing utility service, coordinate and schedule interruptions with Owner. Notify Owner at Least 48 hours prior to scheduled interruption.

1.03 QUALITY ASSURANCE

- A. Conference: Before any work is started, contact the Owner concerning the work under this contract.
- B. Have a competent supervisor on site at all times while work is in progress. This supervisor must have the authority to act in a decision making capacity.
- C. Ensure proper coordination and cooperation between irrigation and other work to enable work to proceed rapidly and efficiently.
- D. Confine irrigation operations to the area to be improved and to the areas allotted by the Owner for material and equipment.
- E. Take all necessary steps to protect existing site conditions and vegetations. (Obtain Owner's approval in areas near existing vegetation before excavating).
- F. Meet all applicable codes.
 - 1. All applicable local codes and ordinances.
 - 2. Plumbing Code 2000 Edition with Georgia Amendments.
 - 3. International Building Code 2000 Edition with Georgia Amendments.
 - 4. National Electrical Code 2002 Edition with Georgia Amendments.
 - 5. Should Drawing's or Specification's requirements differ from local requirements, consider contract document requirements to be minimum acceptable and comply with any more stringent local requirements.

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- G. Obtain all applicable permits and fees at no additional cost to the Owner.
 - 1. Obtain all permits and pay required fees to any agency having jurisdiction over the work.
 - 2. Arrange inspections required by local ordinances during the course of construction.
 - 3. Upon completion of the Work, provide satisfactory evidence to show that all work has been installed in accordance with the ordinances and code requirements.

- H. The Owner reserves the right to reject any and all materials and workmanship which is deemed not to be in accordance with Drawings and Specifications. Rejected materials and work must be removed from site immediately and replaced with that of the specified quality.

- I. A Sub-contractor who repeatedly produces work that does not meet the Owner's specifications may be removed from the job site. Payment for a percentage of work completed will be determined by the Owner.

- J. Give 48 hour notice to the Owner for a minimum standard inspection. This inspection will include: Installed section of the irrigation system including main line, at least one valve, section line and several irrigation heads. No irrigation equipment is to be buried until this inspection is complete. This approval will constitute the Minimum Standard of Acceptance for all work on the site. Any necessary re-excavation or alteration to the system needed because of failure to have the required review will be performed at no additional cost to the Owner.

- K. Substantial Completion: Once the entire irrigation system has been installed, request (48 hours in advance) an inspection by the Owner. If the Owner approves the work, it will be deemed Substantially Complete. At this time the Owner will complete a punch list of items requiring correction. These adjustments and corrections to the system will be made at no additional cost to the Owner and may include nozzle changes and risers if necessary to provide optimum performance.

- L. Full Acceptance: Upon completion of the items on the punch list and the transmission of all required submittals, including a certificate of warranty registration and a written guarantee of work and materials, request a final inspection by the Owner. This inspection will be done within 5 days of notification. If the Owner finds the punch list to be satisfied and all other requirements of the Contract to be complete, he will pronounce the work to be in Full Acceptance and will approve final payment.

1.04 WARRANTY

- A. Upon substantial completion, submit a certificate of warranty registration and a written guarantee of work and materials. In addition to manufacturer's guarantees and warranties, this guarantee must run for a period of one full year beginning on the date of Full Acceptance of the irrigation system by the Owner.

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- B. During the period of guarantee immediately replace all work not functioning correctly make adjustments as necessary to maintain complete coverage and repair damage to grade, plants and other work or property as necessitated due to irrigation defects, repairs, replacements or adjustments. All repairs and replacements must be done promptly and at no additional cost to the Owner.
- C. If replacement is not acceptable during or at end of the guarantee period, Owner may elect either subsequent replacement or credit. Replacement products must have a similar one-year guarantee from time of replacement.
- D. Guarantee applies to all losses with exception of those due to acts of God, vandalism, or neglect, as determined by Owner.
- E. Upon Full Acceptance of the system, verbally instruct the Owner's personnel in the operation and maintenance of the system. All written instructions will be included. (See Submittals 1.01 - D). Supply the Owner with any keys, wrenches or adjusting tools needed to operate and maintain the system. Be responsible and available to maintain the system and insure it is running properly for a period of 30 days from this date. During this period the Owner or Owner's personnel will continue to receive instruction on the operation and maintenance of the system.
- F. In the fall, following installation, service and winterize the system at no additional cost to the Owner. Future winterization of the system shall be explained in the maintenance literature (Section 1.01 - Submittals).

PART 2 - PRODUCT

2.01 PVC PIPE (POLYVINYL CHLORIDE PIPE)

- A. Marking and Identifications: PVC pipe is to be continuously and permanently marked with the following information: Manufacturer's name, pipe size, type of pipe and material, SDR number, ASTM standard number and NSF (National Sanitation Foundation) seal. The pipe is to be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles and dents.
- B. Four Inch and Larger Pipe: All piping four (4) inches and larger will be equipped with gaskets. All fittings for pipes four (4) inches and larger will be equipped with gaskets.
- C. Lateral Line Pipe: All lateral line pipe to be Schedule 40.
- D. Main Line Pipe: All main line pipe to be Schedule 40.
- E. Pipe Size: Pipe sizes to conform to those shown on the Drawings. No substitutions of smaller pipe sizes will be permitted, but substitutions of larger size may be approved.

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All pipe damaged or rejected because of defects must be removed from the site at the time of said rejection.

2.02 PVC FITTINGS

- A. Plastic Fittings: All plastic fittings to be installed are to be molded fittings manufactured of the same material as the pipe and suitable for solvent weld, slip joint ring tight seal, or screwed connections. No fitting made of other material are to be used except as hereinafter specified.
- B. Slip Solvent Weld Joints: Slip fitting socket tapers are to be so sized that a dry unsoftened pipe end can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted.
- C. Threaded Joints: Only Schedule 80 pipe may be threaded. Teflon tape or liquid teflon must be used on these joints.

2.03 CONTROLLER, SENSORS, AND WIRE

- A. Automatic Controller: Provide the automatic controller as specified in the Drawings. Valves will be made by the same manufacturer.
- B. Automatic Rain Shut Off: Provide a or rain sensor device to override the controller in the event of rain.
- C. Freeze Sensor: Provide a freezer sensor device to override the controller in the event of freezing weather.
- D. Control Wire: Control wire is to be Type UF, UL approved for direction burial and gauge 14 or larger.
- E. Wire Splice: Joining of underground wires is to be made with watertight connectors in valve boxes. No splicing between boxes is acceptable.

2.04 IRRIGATION VALVES

- A. Electrical Zone Control Valves: Globe-type diaphragm valves of normally closed design. Operation accomplished by means of an integrally mounted heavy-duty 24 volt AC solenoid complying with National Electrical Code, Class II Circuit, solenoid coil potted in epoxy resin within a plastic-coated stainless steel housing. Solenoids must be completely waterproof, suitable for direct underground burial. Provide a flow stem adjustment in each valve. Valves are to be by the same manufacturer as the automatic controller.
- B. Manual Valves: All manual valves are to be full port ball valve type constructed of solid brass.

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C. Quick Coupler Valves: All quick coupler valves will be solid brass.

2.05 VALVE BOXES

A. Install all valves in thermoplastic valve access boxes of the size required to permit access to the valve. Valve boxes are to include black thermoplastic locking covers. Manufacturer - Carson or approved equal.

2.06 IRRIGATION HEADS

A. Irrigation heads are to be of the brand and series specified in the drawings or approved equal.

2.07 SLEEVES

A. All sleeve shall be of Schedule 40 or stronger pipe and shall be of the size(s) noted on the Drawings.

2.08 BACKFLOW DEVICE AND PRESSURE REGULATOR

A. Backflow device and pressure regulator are to be of the brand, type, and model specified in the Drawings or approved equal.

PART 3 - EXECUTION

3.01 GENERAL INFORMATION

- A. Verify existing and proposed locations of all site utilities (i.e. gas, water, electric, telephone) prior to any trenching and laying of pipe.
- B. Coordinate all irrigation of work with that of all other site work trades and contractors.
- C. All piping is to be installed directly behind curb where possible and in all cases to be routed around existing trees and shrubs. Refer to the landscape planting drawings for approximate tree locations. Closely coordinate work and schedule with grading and planting work.
- D. Be responsible for full and complete coverage of all areas designated on the drawings to be irrigated and make any necessary adjustments at no additional cost to the Owner.
- E. Exact location and configuration of features may vary from that shown on the Drawings. Verify location and configuration of proposed sleeves at the site prior to trenching for

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sleeves and piping under paving, and make any minor adjustments to irrigation system layout. Notify Owner of substantial changes.

- F. Maintain all warning signs, barricades, bracing, flares, and red lanterns as required by safety regulations and local ordinances. All ditches and holes left uncovered overnight must be barricaded to protect the public.

3.02 SLEEVES

- A. All sleeves under proposed pavement must be installed prior to subgrade and base construction.
- B. Sleeves to have a minimum of 12" and a maximum of 18" clearance below bottom of curb.
- C. Stub up sleeve pipe eighteen (18) inches above ground surface and cap. Paint cap with florescent orange paint and attach ribbon flagging to pipe stub for easy identification.
- D. All sleeves are to be installed as located on the plans. Notify the Owner of any adjustments necessary to accommodate existing vegetation, utilities, or other existing conditions.
- E. If road crossings are designated as being bore locations the bore must be of ample size to accommodate the size sleeve specified in the Drawings.

3.03 EXCAVATION AND TRENCHING

- A. Restore all surfaces and existing underground installations damaged or cut as a result of the excavations, to their original condition and in a manner approved by the Owner.
- B. Trenches shall be 4" wide and to the depth required as specified herein. Over-excavations must be backfilled with clean soil. Trenches are to have sides as nearly vertical as possible and bottoms shaped to provide continuous bedding of each section of pipe along its entire length in undisturbed soil or thoroughly compacted fill. In the event that rocky soil is encountered, trenches will be excavated and additional 3" deeper and filled with clean soil or sand to provide smooth bottom. All trenches and holes must meet local and federal regulations for safety and proper shoring.
- C. Remove all unsuitable or excess material from the site.
- D. Dewater excavations as required for dry work including both surface and ground water.
- E. Backfill in six (6) inch compacted lifts as needed to bring the soil back to its original density.

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- F. In the spring following the year of installation, repair any settlement of the trenches by bringing them to grade with topsoil, and sodding with existing lawn type(s). Watering and maintenance of the repaired areas shall be the Owner's responsibility.
- G. Take care in existing lawn areas to limit the extent of disturbance to the lawn. All disturbed lawn areas are to be brought to grade and sodded to match prior conditions.

3.04 PIPE INSTALLATION

- A. Plastic pipe is to be installed in a manner that permits expansion and contraction as recommended by the manufacturer.
- B. Plastic pipe is to be cut with a handsaw or hacksaw in a manner ensuring a square cut. Thoroughly clean pipe and fittings of dirt, dust and moisture before applying solvent. Burrs at cut ends must be removed prior to installation so that a smooth unobstructed flow will be obtained.
- C. All plastic-to-plastic joints are to be solvent-welded joints or slip seal joints. Only the solvent recommended for the pipe and fittings may be installed as outlined and instructed by the pipe manufacturer. Replace improperly installed pipe at no additional cost to the Owner.
- D. The joints must be allowed to set at least twenty-four (24) hours before pressure is applied to the system on PVC pipe.
- E. Minimum depth of cover over lateral piping is twelve (12) inches, and over mainline pipe is be eighteen (18) inches.
- F. Tape or plug ends of uncompleted piping at end of each work day. Flush lines as required to remove debris.

3.05 IRRIGATION HEADS

- A. Prior to installation, verify configuration of planting areas and tree locations, and stake head layout accordingly. Obtain approval of staked head locations from Owner before proceeding.
- B. All heads are to be attached as specified. No "funny pipe" will be accepted.
- C. Adjust head height after planting and sod installation. Heads are to be set plumb. All sprinkler heads must be positioned to prevent contact with lawn mowers.
 - D. Provide proper nozzle model from series to obtain pattern and coverage required as recommended by manufacturer and to irrigate areas indicated on Drawings.

3.06 VALVE INSTALLATION

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- A. Provide valves in accordance with the materials list and the manufacturer's recommendations; set in a level position.
- B. Group valves together where possible. Locate valves in pine straw where possible. Locating valves in pine straw or mulch areas is preferred over turf areas.
- C. All valves are to be covered with a box at least 10" in diameter. Drain stone (1 cubic foot, 6" depth) is to be located under each valve box.
- D. Valve, meter, pressure regulator and backflow preventer boxes are to be set 1" above finished grade. Completely drill through all finger holes in the lid and remove burrs. All hose bibb boxes, isolation valve boxes, and zone valve boxes must be identified with a three inch yellow paint stencil on the top of the lid. Hose bibbs are to be designated "H.B.", isolation valves are to be designated "I.V.", and zone valves are to be designated by the corresponding zone number.

3.07 CONTROLLER AND CONTROL WIRING

- A. Controller and electrical valves on the job must be from the same manufacturer.
- B. All high voltage (120 230 volt) electrical connections must be performed by a licensed electrician and must meet National Electrical Codes, 2002 Edition with Georgia Amendments.
- C. Provide control wires with sprinkler mains and laterals in common trenches wherever possible. Wiring is to lay under lateral lines. Provide looped slack at valves and snake wires in trench to allow for contraction of wires. Tie wires in bundles at intervals of 10 feet.
 - 1. Provide a 10-inch loop in wire and/or tubing at each valve where controls are connected.
 - 2. Provide a 10-inch loop in wires and/or tubing at intervals not to exceed 100'.
- D. No splices will be made outside of valve boxes. Make all electrical splices waterproof.
- E. Control wires installed beneath walks, drives, or other permanent surfaces are to be placed in sleeves.

3.08 FLUSHING AND TESTING

- A. Flush main line thoroughly.
- B. Flush spray head lateral lines prior to nozzle installation.
- C. Before flushing rotor lateral lines, remove all rotors from their canisters, flush the line and replace rotors.

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- D. Contact Owner 24 hours prior to pressure testing main line. Sprinkler main are to be tested under normal water pressure for a period of twelve (12) hours. If leaks occur, repair and repeat the test.
- E. After backfilling and adjusting heads to final positions, demonstrate to the Owner that the system meets coverage requirements and controls function properly. Adjust heads to be no more than 1/2" above finish grade.

3.09 CLEAN UP

- A. Keep site clean on a daily basis by removing trash and debris resulting from construction operations.
- B. Keep all walks, roads and circulation routes free from debris, materials and equipment at all times.
- C. Upon completion of the irrigation work, clean up all work and storage areas by removing trash piles, surplus material or other material from site.
- D. Restore pavement, curbs, ground and any other disturbed surface to its original condition.

PART 4 - CODES, PERMITS, WARRANTY, AND GUARANTEE

4.01 CODES AND ORDINANCES

- A. All materials and operations are to conform to all applicable codes and ordinances. Investigate and follow all regulations.

4.02 PERMITS AND FEES

- A. Obtain all required permits and pay all required fees. Any penalties imposed due to failure to obtain any permit or pay any fee will be at no additional cost to the Owner.

END OF SECTION 32 9100

SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Submit two copies, minimum, supplier's information on seed and/or hydroseed mixtures including rate of application and recommended application dates.

1.02 PROJECT CONDITIONS

- A. Provide topsoil, seeding and sodding for complete installation of grassed areas as shown on drawings.

1.03 QUALITY ASSURANCE

- A. Applicable Publications: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 1. U.S. Department of Agriculture: Federal Seed Act of August 9, 1939 (53 Stat. 1275) Rules and Regulations.
 2. Bulletin 773: Lawns in Georgia. Cooperative Extension Service: University of Georgia College of Agriculture, revised April 2000.
 3. Association of Official Analytical Chemists (AOAC) Publication: Official Methods of Analysis (13th Ed., 1980 and Suppl 1, 2, 3 and 4).

1.04 WARRANTY

- A. Guarantee all seeded grasses to germinate and grow to a height of one inch. Evenly distribute grass over the site. Reseed bare spots at no cost to the Owner within a period of four weeks after the initial installation, and prior to final acceptance by the Owner. The acceptable standard for seeded lawns is when scattered bare spots, not greater than one square foot, do not exceed 3% of the lawn area.
- B. Guarantee all sod grasses to be actively growing and/or taking root within 8 weeks after the installation date.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Topsoil: Existing Topsoil: Suitable topsoil is to be stripped from construction areas and stockpiled. Use topsoil to bring landscaped areas to finished grade. Dispose of any stored topsoil remaining after all work is in place. Indicated areas not stripped but to be seeded, are to be prepared as hereinafter specified.
- B. New Topsoil: If stockpiled material is not sufficient to complete all indicated work provide additional topsoil from approved sources off the site. Topsoil provided must be a natural friable silt loam soil, representative of productive soils in the vicinity. It must be obtained from well-drained areas, free of admixture of subsoil and foreign matter or objects larger than 2 inches in diameter, toxic substances, and any other material or substances which may be harmful to plant growth.
- C. Mulch Materials: Acceptable mulch materials will be any of the following or any locally available material approved by the Owner. Mulch material which contains noxious weed or other plants detrimental to the site or adjacent property will not be acceptable. Straw or other material which is excessively brittle, or badly decomposed, will not be acceptable.
 - 1. Straw: The threshed stalks of oats, wheat, barley, rice, rye, beans or peanuts containing not more than 15 percent moisture.
 - 2. Hay: The leaves and stems of plants as timothy redtop, sudan grass, alfalfa, clover and broom sedge hay or native grasshay such as bluestem mixtures containing not more than 10 percent moisture.
 - 3. Wood Cellulose Fiber Mulch: Air-dried, color-dyed, containing no growth or germination inhibiting factors. The material must be manufactured and packaged in such manner that when added to water with fertilizer, and grass seed, agitation will readily cause separation of fibers and uniform suspension to form a homogenous slurry which when applied to soil will permit water to percolate to the soil. The material is to be supplied in packages having a gross air dry weight not in excess of 100 pounds (equivalent to 10 percent moisture).
- D. Commercial Fertilizer: Uniform in composition, free-flowing, suitable for application with approved equipment and manufacturer's guaranteed analysis and in conformity with state fertilizer laws. Fertilizer is to contain following minimum percentages of plant food by weight:
 - 1. 5% available Nitrogen (for seed) 10% available Nitrogen (for sod)
 - 2. 10% available Phosphoric Acid
 - 3. 10% available Potash
- E. Lime: Agricultural ground or pelletized limestone, Lime-Rite or equivalent.
- F. Sod: Delivered to the site within 18 hours after stripping, and a healthy green color and free of diseases, fungus, insects, insect eggs or nematodes. Sod must be free of

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noxious weeds and weed seeds. A written invoice from the sod farm is to be provided showing proof of variety and correct date and time of stripping. Sod must have a rooted soil layer of approximately $\frac{3}{4}$ to 1 inch. Pieces of sod with less than the minimum soil attached will not be accepted. Sod which has been overseeded with perennial grasses is not acceptable under any circumstances. Sod which has been overseeded with annual rye grass is acceptable only if specified.

PART 3 - EXECUTION

3.01 PREPARATION OF SITE

- A. **General:** The areas to be treated and their respective requirements for seed, fertilizer, lime, and other treatment are specified herein. Equipment necessary for the proper preparation of the ground surface and for handling and placing all required materials is to be on hand, in good condition, and approved before the work is started. Demonstrate before starting work that the application of the materials required will be made at the specified rates.
- B. **Clearing:** Prior to placing topsoil, tillage, seeding, or other specified operations, all vegetation which might interfere with the indicated treatment of the areas is to be mowed, grubbed, raked and the debris removed from the site. Prior to or during grading and tillage operations the ground surface must be cleared of materials which might hinder final operations.
- C. **Grading:** All grassed areas which have been rough graded to 4 inches below finished grade must be maintained in a true and even condition prior to distributing topsoil.
- D. **Distributing Topsoil:** The topsoil shall be uniformly distributed on the designated areas and evenly spread to a minimum thickness of 4 inches. Prior to placing the topsoil, the subgrade must be loosened by disking or by scarifying to a depth of at least 2 inches, to permit bonding to the subgrade. Any irregularities in the surface resulting from distributing topsoil or other operations must be corrected in order to prevent the formation of depressions where water will stand. Do not place topsoil when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to the proposed planting or to proper grading.
- E. **Tillage:** After the areas required to be seeded have been brought to the grades shown on the drawings or as specified, thoroughly till to a depth of at least 4 inches by plowing, disking, harrowing, or other approved methods until the condition of the soil is acceptable. Work only during period when beneficial results are likely to be obtained. When conditions are such, by reason of drought, excessive moisture, or other factors that satisfactory results are not likely to be obtained, work shall be stopped. Work may be resumed only when desired results are likely to be obtained.

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- F. Distribute Application of Lime: Immediately following or simultaneously with incorporation of fertilizer, lime uniformly at a rate specified by soils report (at a minimum rate of 2000 pounds per acre or 50 pounds per 1,000 square feet to raise ph in clay 10 mm 1.0 point). Incorporate into the soil to a depth of at least 4 inches by disking, harrowing, or other acceptable methods. Incorporation of lime together with fertilizer may form a part of tillage operation hereinbefore specified.
- G. Leveling: Any undulations or irregularities in the surface resulting from tillage, fertilizing, liming, or other operations must be leveled or rolled before seeding or sodding operations are begun while maintaining positive drainage. Hand rake and smooth, removing all rocks larger than 1" from the surface. Use metal screen or wooden drag on larger surfaces. Contact the landscape architect for an inspection of the fine graded surface, prior to any sod installation.

3.02 SODDING

- A. The planting season for warm season vegetative grasses is May-July.
- B. Place sod within 18 hours of stripping.
- C. Grade to be 1/2 inch lower than paved surfaces for Bermuda and Zoysia sod.
- D. Sod strips to be carefully handled so that tearing and ripping does not occur. Sod to be kept moist at all times.
- E. Sod strips to be placed carefully to ensure that there is no overlapping and no gap between pieces. All joints to be off-set in relation to previous joints.
- F. When laying sod around planting beds, outline the bed with full pieces of sod. If patches of sod must be used they are to be no smaller than 8 inches in either dimension, and used to fill the middle of the sodded area rather than around edges.
- G. Water sod immediately after planting.
- H. Roll all sod areas after planting.
- I. Erect barricades as needed to protect newly sodded areas from traffic or other use. If necessary, provide plywood for use as walking planks.

3.03 MAINTENANCE OF LAWN AREAS

- A. Maintenance must begin immediately after seeding or sodding and must continue until final acceptance of the work in total by the Owner.
- B. Weed, water and treat for any disease, fungus or insect damage which may occur during this period. The amount of water needed will vary greatly, but generally the

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area should be slowly soaked a minimum of twice per day for 10 days, then increasing the duration and decreasing the frequency of watering. Increase or decrease this schedule as weather and site conditions require to maintain the soil in optimum transplant condition. Seeded lawns must be kept moist, not wet, until germination, and then decrease the frequency of watering.

- C. Additional fertilizer needs or mowing needs are to be handled in a separate contract with the Owner. Notify the Owner in writing if fertilizing or mowing is needed during the period until final acceptance.

END OF SECTION 32 9200

SECTION 32 9300

PLANTS

PART 1 - GENERAL

1.01 SUBMITTALS

Not Applicable

1.02 PROJECT CONDITIONS

- A. Extent of landscape development work is shown on drawings and in schedules.
- B. Provide all labor, materials and equipment required by or inferred from drawings and specifications to complete the work of this section.
- C. Before commencing any work required by the contract, verify the location of all utilities, subsurface drainage and underground construction. Damaged utilities resulting from work covered in this contract will be repaired or replaced at no additional cost to the Owner.

1.03 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. American Standard for Nursery Stock (ANSI Z60.1-2004) by the American Nursery and Landscape Association.
- B. The selection of all materials and the execution of all operations required under the specifications and drawings shall be subject to the approval of the Owner. The Owner shall have the right to reject any or all materials and any and all work which, in their opinion, does not meet the requirements of the contract. Promptly remove all rejected materials from the site.

1.04 WARRANTY

- A. The guarantee period for all trees, shrubs and ground cover begins at the date of final acceptance by the Owner.
- B. Guarantee all for a period of one year, beginning at the date of final acceptance.

PART 2 - PRODUCTS

2.01 PLANTS

- A. Specific requirements concerning the various species and the manner in which they are to be provided are shown in the drawings and plant list.
- B. Quantity and Size: Plants must be nursery grown, freshly dug, normally shaped, and well branched, fully foliated when in leaf and shall have healthy, well-developed root systems. Trees must be self-supporting, with straight trunks and with leaders intact. Trees with a double central leader, or pruned central leader will not be accepted. Plants specified as multi-trunk must have completely separate trunks from the ground level; with no overlapping, and a minimum of 5 inches between trunks. All plants furnished must be free of any insect infestations or their eggs, and must have been grown under climatic conditions with temperature extremes similar to those of the locality of the project for a minimum of two years prior to use of the project. All plants must be true to species and variety. Plants used where symmetry is required are to match as nearly as possible. No substituting will be permitted without written permission.
- C. Stock furnished in a size range specified will be interpreted to mean that not less than 50% are to be of the maximum size specified within each range.
- D. The determining measurements for trees is the caliper, height, and spread. Caliper is taken 6" above the ground for trees up to and including 4" in caliper and at 12" for larger sizes. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to tip. Take measurements with branches in normal position.
- E. Plants larger in size than those specified may be used with approval of the Owners at no additional cost. If the use of larger plants is approved, the ball of earth or spread of roots is to be increased proportionately.
- F. Plants must be handled carefully during all phases of installation. Plants are not to be thrown or dropped from the truck. Plants with broken branches or broken rootballs will not be accepted.
- G. Plants that cannot be planted immediately on delivery must be kept in the shade. The roots must be well protected with soil or humus, and must be kept moist. Plants must not remain unplanted for longer than three days after delivery and must not be stored on paved surfaces.

2.02 MULCHES

- A. Mulches, normally pine straw, will be clean and free of branches, cones, leaves and other foreign matter. Application will be a 3" layer after settling over all planted areas.

2.03 FERTILIZER

- A. Shrubs and ground covers are to be fertilized when planted, with slow release Wood-Ace tablets or their equivalent. Balanced, slow release fertilizer such as 16-4-8, in powdered form, is also acceptable if it is mixed well with the planting soil. Apply at the rate of two tablespoons per foot of height, or spread; whichever is greater.

2.04 SOIL AMENDMENTS

- A. Humus: Soil amendment for planting of shrubs and groundcovers consists of ground pine bark humus, "Nature's Helper" or equivalent. Humus must be free of large bark pieces (over 2"), or gravel and must be properly aged and disease and mold free. Mix humus with topsoil as necessary for backfilling of plants.
- B. Topsoil: Provide sufficient topsoil to be used for planting operations. On-site stripped and stockpiled topsoil may be used as supply may indicate. Topsoil used must be a natural, friable soil, capable of supporting plant life, free of large (2" or larger) lumps, rocks or debris, weeds or any other undesirable matter.

2.05 STAKING MATERIALS

- A. Where wood stakes are specified, stakes for supporting trees are to be nominal 2 inches square or round, minimum 8 feet long, sound wood and free of knots.
- B. Strapping Material: Use soft, flexible material, manufactured specifically for tree anchoring – woven polypropylene webbing or, rubber strip with grommets for wire attachment to stake.
- C. Wire for guys between stake and strapping material is to be new #F18 gauge, pliable, galvanized steel wire.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examine conditions under which planting is to be installed, review applicable architectural and engineering drawings, and be familiar with alignment of underground utilities before digging.
- B. Planting time: Planting operations are to be performed at such times of the year as the job may require, with the stipulation that the plant material as specified herein are guaranteed. Plant only during periods when weather conditions are suitable.

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- C. Layout individual tree and shrub locations and areas and secure Owner's acceptance before start of excavation for planting work.
- D. Notify Owner of adverse sub-surface drainage or soil conditions. State conditions and submit a proposal for correction including costs. Obtain approval for method of correction prior to continuing work in the affected area. In the event that alternate locations are selected, prepare such areas at no additional expense to the Owner.

3.02 PLANTING PITS

- A. Verify proper water percolation from all planting pits. In parking lots or urban planting situations, perform simple perc tests over representative areas of the site. This test shall consist of: first, digging the planting pit, then filling the pit with water. When this water drains, fill the pit with water again. If the first or the second filling does not drain within 6 hours, drill the bottom of the pit to break the hardpan. Repeat the perc test. If the planting pits do not drain within 6 hours, notify the Owner in writing.
- B. Prepare planting pits as specified and as shown on the drawings.
- C. For shrubs and ground cover soil amendment, use ground pine bark humus in the proportion of one third part humus to two thirds existing soil. Mix well with soil removed from planting pit. Remove clumps, debris & rocks which are 2 inches or larger. No additional soil amendments are required for trees. Plant trees per the above instructions, using topsoil to replace soil volume if needed.

3.03 INSTALLATION OF B & B PLANTS

- A. All trees must be set so that when settled they will occur approximately 2" above the finished grade and also 2" above the grade that they bore to the natural grade before transplanting. Each plant is to be planted neatly in the center of the pit.
- B. Use planting soil mixture to backfill plant pits. When plant pits have been backfilled approximately 2/3 full, water thoroughly before installing remainder of soil to top of pit. When finish grade is reached, tamp soil lightly to eliminate air pockets, and water thoroughly.
- C. Set plants plumb and brace rigidly in position until the planting soil has been tamped solidly around the ball and roots. Plants are to be properly oriented for best appearance.
- D. Cut ropes or strings or wire from top of the rootball after the plant has been set and lay open the burlap. Leave burlap or cloth wrapping intact around the edge of rootball. Cut and remove the top 12 inches of wire baskets after the plant has been set.

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- E. Form shallow saucers to the finished grade outside the tree pit approximately 4"-6" height capable of holding water about each plant by placing a mound of topsoil around the edge of each filled-in pit.

3.04 INSTALLATION OF CONTAINER PLANTS

- A. Shrubs must be set so that they are level with finished grade after setting. Azaleas, rhododendron, and plants in poorly draining areas are the exception, and shall be planted 4-6" higher than finished grade; and mounded with a mixture of half topsoil and half pine bark humus.
- B. Container plants which have roots circling the bottom of the container, but which are not yet "root-bound" may be used.
- C. Set plants in the center of each pit and backfill until approximately 2/3 full. Tamp gently and continue backfilling. When finished grade is reached, tamp soil and water thoroughly.
- D. Container plants of 10-gallon or larger are to be planted as per tree installation specifications: planted 2-3" higher than finished grade, staked or guyed, and with shallow saucers provided.

3.05 PREPARING A PLANTING BED

- A. Areas to be planted with ground covers, herbaceous perennials, roses or annuals are to have special bed preparation as follows.
- B. Rototill the entire planting area to a depth of 10 inches. Remove rocks, debris, hardpan soil or any other materials which may interfere with plant growth.
- C. Add the following amendments per 100 square feet of planting bed:
 - 1. 5 bags (2 cu.ft.) - pine bark
 - 2. 3 bags (50 lb.) - cow manure
 - 3. 4 bags (50 lb.) - peat moss
- D. Add 10-10-10 fertilizer or an equivalent at the rate of 2 pounds per 100 square feet. Rototill and incorporate thoroughly into the existing soil.
- E. For roses and annuals, lime shall be incorporated into the improved soil at the rate of 4 pounds per 100 square feet.
- F. Arrange plants in staggered rows per spacing on the plan or plant list.
- G. Provide such that plants are even with finished grade after soil has settled. Gently press soil around root systems so that all roots are covered.

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- H. Annual flowers are to be mulched with 3-4 inches of mini-chip size pine bark rather than pine straw or bark nuggets.

3.06 EDGING THE PLANTING BEDS

- A. All planting beds, flower beds and tree pits are to be edged with trench edging unless otherwise specified.
- B. Trench edging is to be in smooth flowing lines as indicated on plans, and shall be 4 inches deep and approximately 4 inches wide.
- C. Trench edging must have a vertical cut on the lawn side, and a sloping cut on the mulch side.
- D. Mulched beds which are adjacent to paved surfaces are to be edged to a depth of approximately 2 inches. Trench edging is not to be as deep as the pavement under any circumstances.

3.07 RAKING PLANTING BEDS

- A. All planting beds are to be raked smooth, and all rubble, stones and debris removed from the site.

3.08 APPLYING PRE-EMERGENT HERBICIDE & MULCHING

- A. Ronstar pre-emergent herbicide is to be applied to all ground cover and shrub beds at the manufacturer's recommended rate of 3 lb. 7 oz. per 1,000 S.F.
- B. Immediately after the planting has been completed, a layer of pine straw or other specified mulch 3"-4" thick is to be placed on the finished surface about the plant. The mulch around isolated plants must cover the entire area of the pit. Where plants are planted in groups, the entire area between the plants is to be covered with mulch.

3.09 WATER

- A. Water (soak) all plants immediately after planting, and continue thereafter as necessary until acceptance of the work in total. Plants must be watered at least twice per day for ten days after planting, and then once per day for two weeks. After this period increase this schedule if weather conditions are extremely hot, wet or windy. Otherwise, water 30-60 minutes once per week. Water on weekends as needed, until final acceptance.

3.10 STAKING, GUYING AND PRUNING

- A. Any staking is to be completed immediately after planting. Plants must stand plumb after staking in accordance with the detail drawings. Pruning of deciduous plants is

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limited to damaged or injured wood only. Multi-trunk trees should be pruned if necessary, to expose the lower trunks. No plants which have been sheared will be accepted. No trees with a cut central leader will be accepted.

PART 4 - MAINTENANCE

4.01 GENERAL

- A. Maintenance begins immediately after each plant is planted and continues until final acceptance of the work in total by the Owner with the following requirements:
1. Maintenance of new planting consists of pruning, watering, cultivating, weeding, mulching, repairing, additional staking, resetting plants to proper grades or upright position, restoration of planting saucer, and furnishing, supplying, and applying such sprays as are necessary to keep the plantings free of insects and diseases. If planting is performed after grass area preparation, proper protection to grass areas must be provided, and any damage resulting from planting operations repaired promptly. Maintenance is to be provided until the time of final acceptance of the work in total by the Owner upon completion of all work under this contract.
 2. Planting areas and plants must be protected at all times against trespassing and damages of any kind for the duration of the maintenance period. If any plants become damaged or injured, they are to be treated or replaced as directed by the Owner at no additional cost. No work is to be done within, adjacent to, or over any plant or planting area without proper safeguards and protection to the plant material.
 3. Keep all planting and work incidental thereto in good condition by replanting, replacing, watering, weeding, cultivating, pruning, and spraying, reguying, and by performing all other necessary operations to care for promotion of root growth and plant life so that work is in satisfactory condition at acceptance.
 4. The root system of all plants must be watered at such intervals as will keep the surrounding soil in the best condition for root growth during the transplant period. See 3.09 for more specific information.
 5. All planting and plant materials required by this contract must be in a satisfactory and acceptable condition at time of application for payment.
 6. Sidewalks, streets and other paved areas must be continuously kept clean when planting and maintenance operations are in progress, and the entire work area is to be cleaned at the end of each day's work.

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4.02 FIELD INSPECTION

- A. The Owner shall observe the total work for provisional acceptance upon written request at least ten (10) days before the anticipated date of the observations.

4.03 TERMINATION MAINTENANCE

- A. Responsibility for complete maintenance (exclusive of replacement) shall terminate on the date of final acceptance of the work in total.

4.04 PLANT REPLACEMENT

- A. Replace without cost to the Owner, and as soon as weather conditions permit, all dead plants and all plants not in a vigorous growing condition, as determined by the Owner. Replacement plants are to be of the same size, species and variety specified in the plant list. Replacement plants must be staked, wrapped and mulched as specified.

4.05 CONTRACTOR LIABILITY

- A. Make all necessary repairs to grades, lawn areas, and paving required because of plant replacements. Such repairs are to be done at no extra cost to the Owner.

4.06 REPLACEMENT PLANT ACCEPTANCE

- A. The acceptance of all replacements plants by the Owner shall terminate the Contractor's responsibility for such. In the event that a replacement plant dies, the Owner may elect a subsequent substitution.

END OF SECTION 32 9300

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SECTION 33 1000

WATER UTILITIES

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Submit a minimum two copies of manufacturer's technical product data and installation instructions for piping and products. Submit shop drawings for potable water systems, and maintenance data. Submit record drawings at project closeout.

1.02 PROJECT CONDITIONS

- A. Protect and maintain existing structures, fences, walls, sidewalks, driveways, water, sewer, gas and drain piping, electrical and telephone cables, pedestrian and traffic accessibility. Repair any damage caused during construction at no expense to the Owner.
- B. Notify and obtain the approval of the Owner on the schedule of work. Notify and coordinate work with all affected utility, street and road departments.
- C. Fully comply with the requirements of the Occupational Safety and Health Act of 1970.

1.03 QUALITY ASSURANCE

- A. Applicable standards:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. American Water Works Association (AWWA).
 - 3. Standard Plumbing Code (International Plumbing Code), 2000 Edition with Georgia Amendments.
 - 4. Local Issuing Authority.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

- A. Provide underground-type plastic line markers, manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service, not less than 6" wide x 4 mils thick. Provide blue tape with black printing reading "CAUTION WATER LINE BURIED BELOW".
- B. Manufacturers: Allen Systems, or Seton Name Plate.

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- C. Install continuous line markers located directly over buried line at 6" to 8" below finished grade, during back-filling and top soiling operations.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Where noted on the Drawings, D.I.P. indicates pipe constructed of ductile cast iron pipe. Ductile iron pipe is to be in accordance with ANSI/AWWA C151/A21.51. Pipe to be cement lined as per AWWA C104 (ANSI A21.4) and coated inside and outside with an approved coal-tar coating. Pipe joints to be push-on or mechanical in accordance with AWWA Standard C111 (ANSI A21.11).
- B. Ductile cast iron pipe wall thickness to be Class 50.
- C. Cast iron fittings are to comply with AWWA Specification C110. (ANSI A21.10) The pressure rating must be 350 psi for fittings up to 12 inches and a minimum of 150 psi of larger sizes unless otherwise noted on the drawings. All fittings to be cement lined and coated inside and outside with coal-tar enamel. Wyes and other fittings not included in the AWWA Specification C110 to be as manufactured by American Cast Iron Pipe Company or approved equal.

2.03 COPPER PIPE AND FITTINGS

- A. Seamless Copper Tubing for Service Lines 3-inch and Smaller: Type "K" soft copper complying with ASTM B 88, latest edition. Install with wrought copper (95-5 Tin Antimony solder joint) fittings in accordance with ASME B16.22.
- B. All copper pipe and fittings must bear the seal of approval of the National Sanitation Foundation for potable water service. Copper pipe and fittings is to be supplied from the same source.
- C. Granular Material: When the drawings or Specifications call for gravel, granular material or crushed stone, a clean well graded crushed stone or crushed gravel meeting the requirements of ASTM C 33 - 84 (Gradation 57) is to be provided.

<u>Sieve Size</u>	<u>% Passing (by weight)</u>
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No 4	0-10
No 8	0-5

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2.04 POLYVINYL CHLORIDE (PVC) WATER PIPE AND FITTINGS

- A. PVC pipe is to meet the requirements of AWWA C-900 and comply with ASTM D 2241, rated SDR 21 (Class 150). Pipe to be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 1785 classification.
- B. Pipe joints to be integrally molded bell ends in accordance with ASTM D 3139 and ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.

2.05 VALVES

- A. Gate Valves (2-inch and larger) are to meet the requirements of AWWA C509. Valve to be rated for 250 psi working pressure. Valves to be iron body, bronze-mounted, double disc, parallel seat, non-rising stem type fitted with "O-Ring" seals. The operating nuts to be 2" square. All valves are to open left, or counterclockwise. Stuffing boxed to be the "O-Ring" type. Gate valves to be mechanical joint, ANSI Standard 21.11 except where shown otherwise. Flange joint to be ANSI B16.1 standard. Bell joint to be AWWA Class 150.
- B. Ball Valves (2-inch and smaller) are to have Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.
- C. Butterfly Valves (2-inch to 24-inch) are to meet AWWA C504, and be iron body, bronze disc, resilient replaceable seat, water or lug ends, with infinite position lever handle.
- D. Post Indicator Valves are to be a below grade visual type per _____.

2.06 HYDRANTS

- A. Hydrant: Type as required by utility company, local authority having jurisdiction and as indicated on Drawings.
- B. Hydrant Extensions: Provide in multiples of 6 inches with rod and coupling to increase barrel length.
- C. Hose and Stream Connection: Match sizes with utility company, two hose nozzles, one pumper nozzle.

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- D. Finish: Primer and two coats of enamel or special coating to color as required by utility company.

2.07 ACCESSORIES

- A. Locked Mechanical Joint fittings are to be provided where vertical changes in direction are required and, if approved by the Owner, can be installed in lieu of the above thrust blocking requirements.
- B. Insulating Joints: Joints between pipe of dissimilar metals are to have a rubber-gasketed or other suitable approved type of insulating joint or dielectric coupling which will effectively prevent metal-to-metal contact between adjacent sections of piping.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Use proper and suitable tools and appliances for safe and convenient handling and installing of pipe and fittings. Take great care to prevent the pipe coating from being damaged, particularly cement linings on the inside of the pipes and fittings. Any damage must be remedied as directed. Carefully examine all pipes and fittings for defects just before installing. No pipe or fitting is to be installed which is defective.
- B. If any defective pipe or fitting is discovered after having been installed, it must be removed and replaced in a satisfactory manner with a sound pipe or fitting. All pipes and fittings are to be thoroughly cleaned before they are installed and kept clean until they are used in the completed work. Open ends of pipe are to be kept plugged with a bulkhead during construction.
- C. Pipe laid in trench is to be laid to lie on a firm and even bearing for its full length at depths and grades shown on the plans. Take precautions against flotation.
- D. Where bends and tees occur in pressure mains, pour a block of concrete at the bend or tee to prevent movement of the pipe when in use. The block is to consist of 3000 psi concrete as specified under Division 3 of these specifications, and is to be of size and shape as shown on the plans or otherwise directed by the Owner. Use forms or earth walls to mold the "kick-block"; however, if earth walls are used they are to be cut true to shape with all excess earth removed and the work is to be done in such a manner that no loose earth will become mixed with the fresh concrete. At the end of 24 hours, damp earth may be placed over the concrete to help retain the moisture.

3.02 TESTING

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- A. After all piping has been placed and backfilled between the joints, test each run of newly laid pipe or any valved section thereof, in the presence of the Owner. Tests will be continued until all leaks have been made tight to the satisfaction of the Owner. Furnish all necessary water where such is not available from adjacent mains of the Owner; and all meters, gauges, bulkheads and other material and appliances necessary to conduct the tests as herein required. Every precaution must be taken to remove, valve-off or otherwise protect delicate control equipment in or attached to pipeline to prevent damage or injury thereto.
- B. Test all piping at a minimum pressure of 100 psi above the maximum operating pressure for the period of two (2) hours unless otherwise directed by the Owner. Maximum operating pressure is defined as 150 psi.
- C. Before applying the specified test pressure, all air is to be expelled from the pipe. If hydrants, blow offs, or air release valves are not available at high places, make necessary taps at points of highest elevation before the test is made and insert plugs after the test has been completed.
- D. Prior to the pressure test, pipe laid in trenches is to be partially backfilled adequately to secure the pipe during the test. All joints, fittings and valves will be left open where possible. All exposed pipe, fittings, valves and joints are to be carefully examined during the pressure test. It is the Contractor's responsibility to locate and repair any and all leaks that may develop to the satisfaction of the Owner.
- E. During the final pressure test the specified pressure must be maintained in the pipes being tested for a minimum time of two consecutive hours.
- F. After satisfactory completion of the pressure test, perform a leakage test on each valve section of pipe in accordance with Section 13.7 - Leakage Test of the latest Standard Specifications for Installation of Cast Iron Water Mains, AWWA C 600 (latest revision) at a minimum hydrostatic pressure of 100 psi above the maximum working pressure of the pipe, based on the elevation of the lowest point of the line or lowest point of the section under test and corrected to the elevation of the gauge.
- G. After all tests on any section have been completed to the satisfaction of the Owner, carefully clean, blow out and drain the line of all water to prevent the freezing of same. Demonstrate to the satisfaction of the Owner that any and all lines are free from obstructions and foreign material.

3.03 STERILIZATION FOR POTABLE WATER LINES

- A. Flush out the entire water system.
- B. Introduce chlorine or a solution of calcium or sodium hypochlorite, fill the lines slowly, and apply the agent at the rate which will produce 50 parts per million of chlorine as

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determined by a residual chlorine test at ends of the lines. Open and close all valves and hydrants while the system is being chlorinated.

- C. After 24 hours, test for residual chlorine. If more than 5 ppm are present, flush out the system until all trace is removed.
- D. After sterilization, flush treated water from the system through its extremities. Continue flushing until samples of water are satisfactory to the Gwinnett County Department of Water Resources. Repeat flushing if samples taken daily over the next three days indicate that the quality of the water is not being maintained. Do not draw samples from hydrants and unsterilized hose.

END OF SECTION 33 1000

SECTION 33 3000

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Submit minimum of two copies manufacturer's technical product data and installation instructions for all piping and products.
- B. Submit one reproducible and two blue/black line record drawing at project closeout.

1.02 PROJECT CONDITIONS

- A. Existing structures, fences, walls, sidewalks, driveways, water, sewer, gas, drain piping, electrical and telephone cables, pedestrian and traffic accessibility must be protected and maintained. Repair any damage caused during construction at no expense to the Owner.
- B. Notify and obtain approval from the Owner on the schedule of work. Notify and coordinate work with all affected utility, street and road departments.
- C. Fully comply with the requirements of the Occupational Safety and Health Act of 1970.

1.03 QUALITY ASSURANCE

- A. Applicable standards:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. American Water Works Association (AWWA).
 - 3. Standard Plumbing Code (International Plumbing Code), 2000 Edition with Georgia Amendments.
 - 4. Local Approving Authority.

PART 2 - PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE AND FITTINGS

- A. Where noted on the Drawings, P.V.C. shall indicate pipe constructed of polyvinyl chloride.
- B. Gravity sewer lines and laterals of polyvinyl chloride pipe to conform to ASTM D3034-88, SDR 35.

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- C. Jointing of polyvinyl chloride pipe is to be accomplished by means of elastomeric gasket joints conforming to ASTM D3212-86. Gasket material is to be suitable for use with commercial sewage and conform to ASTM F77-84.
- D. In addition to the requirements of ASTM Specifications, the pipe must not be out-of-round or crooked in alignment as determined by the Owner. Any length of pipe in sizes 8-inch through 12-inch diameter having inside diameters, varying more than 1/4 inch, as measured at right angles to each other, may be rejected.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Where noted on the Drawings, D.I.P. indicates pipe constructed of ductile cast iron pipe. Ductile iron pipe is to be constructed in accordance with AWWA Standard C151 (ANSI A21.51). Pipe is to be cement lined as per AWWA C104 (ANSI A21.4) and coated inside and outside with an approved coal-tar coating. Pipe joints are to be push-on or mechanical in accordance with AWWA Standard C111 (ANSI A21.11).
- B. Ductile cast iron pipe wall thickness is to be computed upon the applicable AWWA Standard and based upon 350 psi minimum working pressure, laying condition "B" and the depth of cover shown on the Drawings.
- C. Cast iron fittings are to be as specified in AWWA C110. Joints to be push-on. The pressure rating to be 350 psi for fittings. All fittings are to be cement lined and coated inside and outside with coal-tar enamel. Wyes and other fittings not included in the AWWA Specification C110 are to be as manufactured by American Cast Iron Pipe Company or approved equal.

2.03 GRANULAR MATERIAL

- A. When the Drawings or Specifications call for gravel, granular material or crushed stone, a clean well graded crushed stone or crushed gravel meeting the requirements of ASTM C 33 - 84 (Gradation 57) must be furnished.

<u>Sieve Size</u>	<u>%Passing (by weight)</u>
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

2.04 MANHOLE FRAMES, COVERS AND APPURTENANCES

- A. Castings must be of uniform quality, free from blow holes, porosity, hard spots, shrinkage, defects, cracks or other injurious defects. They must be smooth and well cleaned by shot blasting and, coated with coal tar pitch varnish of a type which will make a smooth coating, tough and tenacious when cold, not tacky and not brittle.

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- B. Material used in the manufacture of the castings must conform to ASTM A48 83 Class 30 iron for gray iron castings.
- C. All castings must be manufactured true to pattern and with a close fit of component parts. Round forms and covers in roadway and traffic areas must be of non-rocking design or with machined bearing surfaces so that fitting parts will not rattle or rock under traffic.
- D. Frames and covers to have a minimum total weight of 460 pounds. Covers to have a weight not less than 150 pounds.
- E. Manhole covers in roadway and traffic areas to have a minimum thickness along the rim of 1-3/4".
- F. Frames and covers to be of the "Type" shown on the Drawings.
- G. All manhole frames and covers to have a minimum of 22 inches clear opening between the innermost ring. Distance from top to bottom of the frame to be 6 to 8 inches. The lower flange of the frame to be at least 6 inches in width. All covers to be supplied with two concealed water tight pick holes.
- H. Manhole steps to be Clow Corporation F-3650 or equivalent.

2.05 PRECAST MANHOLES

- A. Precast manholes to be as shown on plans.

2.06 CLEANOUTS

- A. Cleanouts for gravity lines to be cast iron soil pipe with fittings conforming to ASTM A74-87, extra heavy.

PART 3 - EXECUTION

3.01 HANDLING MATERIAL

- A. Pipe, fittings and accessories must be loaded and unloaded by lifting with hoist or skidding in a manner that will avoid shock or damage. Under no circumstances will such material be dropped. Pipe handled on skidways must not be skidded or rolled against pipe already on the ground. In distributing the material at the site of the work, each piece must be unloaded opposite or near the place where it is to be laid in the trench.

3.02 INSPECTION AND DISPOSITION OF DEFECTIVE MATERIAL

- A. Inspect all pipe, fittings and accessories for defects before installation. After installation, sewers must be tested for accuracy of alignment and gradient, and for

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exfiltration and/or infiltration in the manner specified in these Specifications and in the presence of the Owner.

- B. All material found to have flaws, cracks, or other defects, whether before or after installation, will be rejected by the Owner. Repair or replace as directed by the Owner at no additional cost.

3.03 OBSTRUCTIONS

- A. Protect work at all times by flagging, marking, lighting and barricading. Preserve and protect all above and underground structures, pipe lines, conduits, cables, drains or utilities encountered. Failure of the Drawings to show the existence of these obstructions shall not relieve the Contractor from this responsibility. Repair any damage which occurs to these obstructions during or as a result of construction, at no additional cost to the Owner.
- B. The Owner shall have full authority to direct the placement of the various pipes and structures in order to facilitate construction, expedite completion and to avoid conflicts.

3.04 MAINTENANCE OF OPERATION

- A. Cooperate at all times with the Owner in order to maintain the operation of the existing water and/or sewer system with the least amount of interference and interruption possible. Public health and safety considerations shall exceed all others. Schedule, plans and work is at all times subject to alteration and revision if necessary for public health and safety considerations. The creation of a public nuisance will not be permitted.
- B. It may be necessary to interrupt the operation of the System. In these cases prepare and submit to the Owner 72 hours prior to commencing the work, a complete description of the proposed procedure and a guaranteed time schedule. At least twenty-four hours prior to the time proposed for starting the work, the Contractor will be notified whether or not the work will be permitted as proposed.
 - 1. The Owner reserves the right to require work 24 hours per day in all cases where, in his opinion, interference with operation of the system may result in dangerous health hazards or offensive conditions.
 - 2. Do not interfere with the existing system until all materials, supplies, equipment, tools and incidentals necessary to complete the work are on the site.

3.05 POWER

- A. Provide all electrical or other power required for construction, testing and trial operation prior to final acceptance by the Owner.

3.06 WATER SUPPLY

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- A. Provide all water required for testing, flushing and construction of Sanitary Sewer System.

3.07 LINE AND GRADE

- A. Sewers must be laid accurately to the line and grade shown on the Drawings and cut-sheets. Tolerances are 1/4" on grade and 1/2" on line in any section between manholes. Deviations exceeding these tolerances may be grounds for rejection of the line. Batter boards to be set at maximum intervals of 25 feet, straight and true. Horizontal members to be securely clamped to steel bar uprights. The last three batter boards to remain in place at all times and constantly monitored to see that the boards are maintained in proper alignment.
- B. Establish, protect and preserve all line and grade stakes with flag stakes, guard stakes or other methods as may be required. Any stakes that are disturbed during construction must be reset at no additional cost to the Owner.
- C. The use of a laser beam to maintain line and grade is permitted.

3.08 PIPE LAYING

- A. Gravity sewer lines must be laid according to the details shown on the Drawings or specified herein. The type foundation to be used is as shown on the Drawings, specified herein, or as directed in writing by the Owner.
- B. The trench bottom must be graded to the proposed elevation of the pipe line and the bottom shaped to fit the lower quadrant of the pipe. Holes are to be excavated at each bell so that pipe is supported along the barrel only. Pipe bedding is to be as described hereinafter.
- C. The storage of pipe on the job site must be done in accordance with pipe manufacturer's recommendations and with the approval of the Owner. Pipe is to be protected during handling against impact shocks and free fall. Pipe laying must not precede backfilling by more than 100 feet without approval from the Owner.
- D. Commence laying of the pipe in finished trenches at the lowest point, with the spigot ends pointing in the direction of flow. The interior of the pipe and the jointing seal must be free from sand, dirt and trash before installing in the line. Extreme care must be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly assembled without over-stressing the bells. The jointing of the pipe is to be done in strict accordance with the pipe manufacturer's instructions and done entirely in the trench.
- E. Each time the work on the sewer is halted for more than one hour, the ends of the pipe are to be sealed to prevent foreign material from gaining entrance to the pipe.

3.09 PIPE BEDDING

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- A. Provide the sewer pipe on the type of bedding specified. The cost of all bedding described herein shall be included in the unit cost for the pipe. Regardless of the type of bedding used, holes in the trench are to be provided to receive the pipe bell. The holes excavated must be sufficient to relieve pipe bells of all load and yet provide support over the total length of the pipe barrel.
- B. Bedding classes are defined below:
 - 1. Class C: Two types of Class C bedding; Class C-1 using a hand shaped trench bottom, and Class C-2 using a gravel bedding.
 - a. For Class C-1 bedding, the trench bottom is to be hand shaped to receive the portion of the circumference of the pipe barrel shown on the Drawings.
 - b. For Class C-2 bedding, gravel is to be compacted in the trench bottom, and compacted around the pipe to the depth shown on the drawings. Use Class C-2 if acceptable bedding cannot be obtained with C-1.

3.10 BACKFILLING

- A. All backfilling necessary to complete the work and the cost thereof shall be included in the Contract prices for the various classes of work. No separate payment will be made for this work.
- B. As a means of dust prevention, by means of a water spray, or other approved method, prevent or abate a dust nuisance arising from dry weather or work in an incomplete stage. Replace all pavements cut or otherwise damaged during the progress of the work as specified elsewhere herein.
- C. Backfill is to be composed of general backfill material, yet not containing large rocks or unsuitable material.
- D. The Owner may reject any material considered unsuitable for backfill. Rejected material must be replaced with suitable backfill material at no additional cost to the Owner. Unsuitable materials must be disposed of off site.
- E. Place backfill from both sides of the trench such that side pressures do not occur. The backfill must be placed so as to prevent after settlement. Any after settlement which occurs will be the Contractor's responsibility, and he must repair any damage to pavement, sidewalks, utility poles, pipes, conduits or lines, structures and any private or public property damaged by such after settlement. The surface of backfill is to be left smooth. Should the work be suspended for any reason for any considerable time, the excavation must be backfilled at no additional cost to the Owner when so ordered by the Owner.
- F. All road crossings are to be backfilled immediately, made passable and maintained passable until the permanent repair is made.

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- G. Where the trench has been dewatered, backfilling is to be placed before the pumps are shut off so that the pipe will not float. Any pipe which has been displaced perceptibly from its correct position will be removed and relaid properly at no additional cost to the Owner.
- H. Backfilling to flow within 100 feet of the pipe laying, unless otherwise directed by the Owner.

3.11 LATERALS

- A. A lateral connection must be provided where shown on the Drawings. The location of laterals are to be determined in the field. Laterals are to extend to the building and terminate with a bell sealed with a plug of an approved design. Mark the location of the end of the lateral with a 2" x 2" stake painted red. The exact station location and length from the main sewer is to be noted on the as-built drawings.

3.12 MANHOLES

- A. All manholes are to be built at point indicated on the Drawings, or as directed by the Owner and are to be constructed to the grade as shown and in strict accordance with the details on the Drawings. Manholes must, in all cases, be fully and completely built and fitted with frames and covers as the work progresses. Manholes are to be precast concrete and shall have a 4-foot internal diameter unless otherwise noted on the Drawings.
- B. Precast concrete manholes meet the requirements of this section. Provide at least 6 inches of compacted gravel under the manhole foundation as well as within the area 6 inches beyond the outside surface of the manhole. Gravel is to be placed around the manhole from the manhole slab to 12 inches below finished grade. Sewers entering the manhole are to be bedded in gravel throughout the length of the manhole cut. Cost of furnishing and installing the gravel is included in the unit cost for the manhole construction. Eccentric top sections are to be used so that manhole opening is not directly over the center of the manhole.
- C. Construct the top of the manholes to the elevation shown on the drawings.
- D. Provide all manholes with the following appurtenances:
 - 1. Frames and covers as specified in this section and shown on the Drawings.
 - 2. Manhole steps 16 inches on center along a vertical line. Steps must be placed perpendicular to the flow of sewage through the manholes so that the person descending the steps will step onto the bench and not directly into the sewer. Ensure that the steps are securely fastened to the walls of the manholes.
 - 3. Channels are to be constructed as shown on the Drawings. Manhole channels, or inverts are to be so constructed so as to permit a smooth transition between the up and downstream sewers. Channels are to be constructed of cement grout or cement mortar brickwork and trowled to a smooth finish.

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3.13 INFILTRATION AND EXFILTRATION TESTS

- A. All gravity flow pipe lines will be subject to tests for leakage. These tests will be subject to the following conditions.
 - 1. Exfiltration tests are to be conducted on every portion of the system including building or house lateral lines unless otherwise waived by the Owner. The water level or internal pressure to be used for exfiltration tests is to be determined by the Owner.
 - 2. Infiltration tests are to be conducted on all portions of the system where the pipe inverts are below the ground water table.
- B. The tests and measurements of infiltration and exfiltration are to be conducted in a manner approved by the Owner, and apply to the whole system or any portion thereof. All tests are to be made and in the presence of the Owner.
- C. Final infiltration and exfiltration tests are to be made after all backfilling operations and pavement restorations are completed and the sewers are cleaned and ready for use. The leakage into or out of the system through the sewers, laterals and manholes, is not to exceed 100 gallons per 24 hours per mile of pipe per inch of diameter except that where exfiltration tests are required or necessary, the joints shall perform equally well, but are permitted for each additional 2 foot head over basic 2 foot minimum internal head. In determining the allowable leakage the length of is shall not included. Stop all visible leaks regardless of any leakage tests.
- D. Provide all water used for exfiltration tests at a quality acceptable to the Owner.

3.14 FINAL TESTS AND INSPECTION

- A. Upon completion of the work, the sewer system, or selected sections therein, will be subjected to a final test and inspection. All work in the system, or sections therein being tested must be complete, cleaned and ready for use. Tests will be as specified herein and shall meet all requirements as to line grade, cleanliness, infiltration, exfiltration and workmanship. No wastewater will be introduced into the system until approval by the Owner is granted.

END OF SECTION 33 3000

SECTION 33 4000

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Product Data: Submit two copies, minimum, for each type of piping material, downspout adapter, prefabricated structure, casting and for compression type joint gaskets. Indicate product descriptions and installation procedures.

1.02 PROJECT CONDITIONS

- A. Provide storm drain pipe and drainage structures

1.03 QUALITY ASSURANCE

- A. Applicable Standards:
 1. American Society for Testing and Materials (ASTM).
 2. American Concrete Institute (ACI).
 3. Georgia D.O.T., "Standard Specifications, Construction of Transportation Systems 2001 Edition", hereinafter referred to as Georgia D.O.T. Specifications.
 4. American Association of State Highway and Transportation Officials (AASHTO, latest edition).
 5. Local approving authorities.

PART 2 - PRODUCTS

2.01 ALUMINIZED (TYPE 2) CORRUGATED STEEL PIPE

- A. Pipe to be circular, conforming to AASHTO M-36.
- B. Corrugations to have a pitch x depth (in inches) of 2 2/3 x 1/2, 3 x 1 or 5 x 1, as noted on the drawings or consistent with manufacturer's requirements. Gage to be determined as per manufacturer's specifications for the finished depth of cover.
- C. Pipe to be fabricated with:
 1. circumferential corrugations and riveted or resistance spot welded lap joint construction or;
 2. helical corrugations and a continuous lock or welded seam, extending from end to end of each length of pipe.

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- D. End Finish: To facilitate field jointing, the ends of individual pipe sections with helical corrugations to be rerolled to form circumferential corrugations extending at least two corrugations from the pipe end.
- E. Coupling Bands: Bands to be fabricated from the same metal type as the pipe and be bituminous coated. Bands to have a minimum of two annular corrugations and fully engage one corrugation on each pipe end.
- F. Gaskets are required at each pipe joint and are to be the O-ring type conforming to ASTM C-361.
- G. Certification: Manufactures certification of compliance with this specification is required.

2.02 POLYVINYL CHLORINE PIPE AND FITTINGS

- A. Where noted on the Drawings, P.V.C. indicates pipe constructed of polyvinyl chloride.
- B. Gravity sewer lines and laterals are to be polyvinyl chloride pipe conforming to Schedule 40.
- C. Jointing of polyvinyl chloride pipe is to be accomplished by means of elastomeric gasket joints conforming to ASTM D3212. Gasket material is to be suitable for use with commercial sewage and shall conform to ASTM F77.
- D. In addition to the requirements of ASTM Specifications, the pipe may not be out-of-round or crooked in alignment as determined by the Owner. Any length of pipe in sizes 8-inch through 12-inch diameter whose inside diameters measured at right angles to each other vary more than 1/4 inch may be rejected.

2.03 REINFORCED CONCRETE PIPE

- A. Pipe is to conform to ASTM C-76 and be of sizes shown on drawings. Class of pipe is Class III unless otherwise noted.
- B. Joints are to be tongue and groove with rubber gaskets or tongue and groove with preformed plastic gaskets.
- C. Rubber gaskets are to conform to ASTM C443. Only a natural agent may be used as a lubricant.
- D. Preformed plastic gaskets are to conform to Federal Specification SS-S-210, Type I-rope form.
- E. Certification: Manufacturer's certification of compliance with this specification is required.

2.04 DUCTILE IRON PIPE AND FITTINGS

- A. Where noted on the Drawings, D.I.P. indicates pipe constructed of ductile cast iron pipe. Ductile iron pipe is to be constructed in accordance with AWWA Standard C151 (ANSI A21.51). Pipe is to be cement lined as per AWWA C104 (ANSI A21.4) and coated inside and outside with an approved coal-tar coating. Pipe joints are to be push-on or mechanical in accordance with AWWA Standard C111 (ANSI A21.11).
- B. Ductile cast iron pipe wall thickness is to be computed upon the applicable AWWA Standard and based upon 350 psi minimum working pressure, laying condition "B" and the depth of cover shown on the Drawings.
- C. Cast iron fittings are to be as specified in AWWA C110. Joints to be push-on. The pressure rating is to be 350 psi for fittings up to 12 inches and a minimum of 250 psi of larger sizes unless otherwise noted on the Drawings. All fittings are to be cement lined and coated inside and outside with coal-tar enamel. Wyes and other fittings not included in the AWWA Specification C110 are to be as manufactured by American Cast Iron Pipe Company or approved equal.

2.05 HIGH DENSITY POLYETHYLENE PIPE

- A. Pipe and fitting material are to be high-density polyethylene meeting ATSM D 3350 minimum cell classification 324420C for 4- through 10-inch diameters or 335420C for 12- through 60-inch diameters. Pipe manufactured for this specification is to comply with the requirements for test methods, dimensions, and markings found in AASHTO M252, AASHTO M294 and/or AASHTO MP7-97. The prescribed sizes of pipes are nominal inside diameters. Pipe sizes are to be no less than 99% of nominal inside diameter and have a minimum of 20.0 feet laying length.
- B. For 4 to 10 inch (100 to 250mm) diameters, the pipe supplied is to be smooth interior and Annular Exterior Corrugated High Density Polyethylene (HDPE) meeting requirements of AASHTO M252, Type S.
- C. For 12 to 48 inch (300 to 1200mm) diameters, the pipe supplied is to be smooth interior and Annular Exterior Corrugated High Density Polyethylene (HDPE) meeting requirements of AASHTO M294, Type S.
- D. For 54 to 60 inch (1350 to 1500mm) diameters, the pipe supplied is to be smooth interior and Annular Exterior Corrugated High Density Polyethylene (HDPE) meeting requirements of AASHTO MP7-97, Type S.
- E. Fittings shall conform to AASHTO M252, M294 or MP7-97. Fabricated fittings are to be welded on the interior and exterior at all junctions.
- F. Install in accordance with ASTM D2321 with the exception that minimum cover in traffic areas shall be one foot (0.3m) for 4"-48" pipe and 18" (0.5m) for 54" and 60" pipe.

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- G. Backfill the pipe with material meeting the requirements o ASTM D2321 Class I, II or III subject to approval of the Architect.
- H. Trench width should be wide enough to place and compact backfill around the entire pipe. The trench width is to be outside diameter +24" for pipe sizes 12" to 30" and outside diameter +36" for pipe sizes 36" to 60".

2.06 CONCRETE, MASONRY AND ACCESSORY MATERIALS

- A. Concrete: 3000 psi compressive strength, in accordance with Section 500 - Concrete Structures, including formwork, reinforcement and finish, Georgia D.O.T. Specifications.
- B. Masonry Materials: Meeting Section 834 - Masonry Materials, Georgia D.O.T. Specifications.
- C. Construction Castings: Meeting Section 854.2.01 - Gray Iron Drainage Castings, Georgia D.O.T. Specifications and local authorities specifications.
- D. Manhole Steps: Meeting ASTM A48, Class 30B, integrally cast into manhole sidewalls.
- E. Gravel Fill: Meeting local authorities specifications #57 stone.
- F. Precast Concrete Manholes: Meeting Section 866 - Precast Concrete Catch Basin, Drop Inlet, and Manhole Units, Georgia D.O.T. Specifications.
- G. Stone Rip-Rap: Meeting Section 805.2.01 - Rip Rap, Georgia D.O.T. Specifications and shall be cubic stone, 2" minimum dimension, weighing approximately 165 lbs./cu.ft.
- H. Plastic Marking Tape: Four mil thickness polyethylene, 6" minimum width, in bright color with the words "SEWER LINE BELOW" printed continuously along length.
- I. Downspout Adapters: Provide a downspout adapter to transition from the downspout to the underground drainage system. The underground drainage pipe is to terminate 4" above the proposed grade at building.

PART 3 – EXECUTION

3.01 CONSTRUCTION OF DRAINAGE SYSTEM

- A. Excavate, fill and compact for construction of drainage system in accordance with Section 31 23 00 Excavation and Fill.
- B. Inspect piping prior to placing in trenches. Install no defective or damaged piping.
- C. Install structures in conformance with the details shown on the plans or as directed. Excavate structure and prepare foundations as set forth in Section 31 23 00 Excavation and Fill. Before pipes are installed, shape the foundation material as shown on the Plans.
- D. Provide necessary temporary drainage.
- E. Before any traffic over a culvert is allowed, provide an adequate depth and width of compacted backfill to protect the structure from drainage or displacement. Any damage or displacement that may occur after installing and backfilling due to traffic or erosion must be repaired or corrected at no additional cost to the Owner. Any debris or silt that constricts the flow through a pipe shall be removed as often as necessary to maintain drainage throughout the life of the Contract. All pipes must be cleaned before the work is accepted.
- F. Installation of Corrugated Steel Pipe:
 - 1. Pipe sections to be laid in a prepared trench with outside laps of circumferential joints pointing upstream and with longitudinal joints at the sides. Coupling bands, fastened by two or more bolts, may not be more than the width of one corrugation.
 - 2. Carefully inspect each section of corrugated steel pipe before laying. Do not use any defective or damaged pipe.
 - 3. Install all gaskets in accordance with manufacturer's product data to ensure complete joint sealing.
 - 4. Lay pipe sections starting at the lowest point on the drainage system and laying upstream.
- G. Construction of Drainage Structures:
 - 1. Excavation and Backfill: Excavation and foundation preparation for these structures and for pipes entering and exiting these is to be in accordance with the provisions of Section 31 23 00 Excavation and Fill. No separate payment will be made for such excavation, backfill, and disposal of surplus material.
 - 2. Concrete: Concrete units to be precast. Construction is to conform to the following:
 - a. Precast Reinforced Concrete Units:
 - 1) Holes for Pipe: Each unit to be cast with pipe holes of the specific number and dimensions necessary to incorporate the unit into the drainage system as shown on the plans. In the event conditions during the installation

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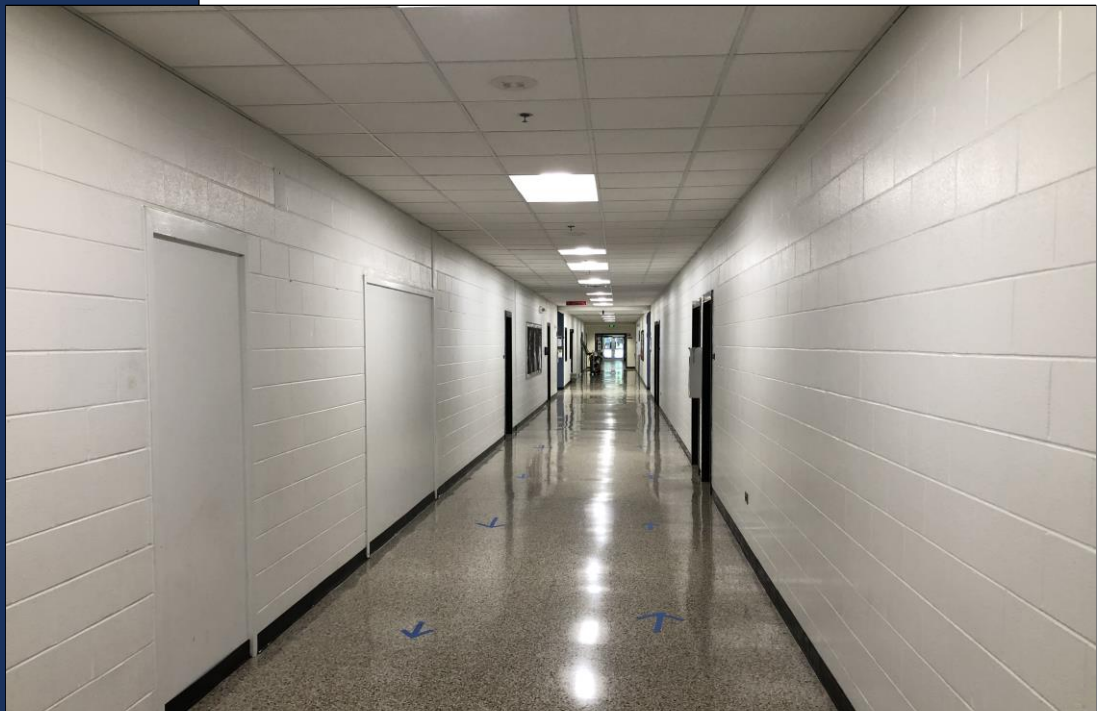
- require additional pipe for which no holes have been cast, the Contractor may, with approval of Owner, make such holes provided he replaces or repairs any damaged units to the satisfaction of the Owner.
- 2) Pipe Connections: Pipe to be connected to units with either Mortar or Class "A" Concrete.
 - 3) Installation:
 - a. Precast Reinforced Concrete Units: Set to within 1/2" +/- of grade on a bed of compacted sand bedding material which is approximately 2 to 3 inches thick.
 - b. Sectional Precast Reinforced Concrete Units: When such units are used to build-up extra depth catch basins or drop inlets, the joints between sections are to be filled with mortar and all such joints shall be wiped smooth.
 3. Brick Masonry: Brick masonry structures to be constructed in accordance with the requirements of Section 608 - Brick Masonry of the Georgia D.O.T. Specifications.
 4. Castings: Frame castings to be securely held in place to proper line and grade and made an integral part of the complete structure. All castings subject to use by traffic to be firm and stable under traffic upon completion of the structure.
 5. Maintenance: All structures to be kept thoroughly clean of all fallen masonry, silt, debris and other foreign matter.
 6. Where manholes occur in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3" above finish surface, unless otherwise indicated.
 7. Backfill at structures and compact as specified for building walls, in accordance with Section 31 23 00 Excavation and Fill.
 8. Install stone rip-rap at locations where water is released from drainage system, to prevent scour. Place stone rip-rap on subgrade compacted in accordance with earthwork section. Place rip-rap in rubble pattern with maximum 1-1/2" joints.
 9. Set drainage gratings to elevations indicated on the drawings. Install plastic masking tape centered over piping locations during backfilling operations. Locate marking tape approximately 9" above sewer line.

3.02 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures, so that the finished work will conform as nearly as practicable to the requirements specified for new work by local authorities Standards and Specifications.

END OF SECTION 33 4000

REPORT OF PRE-RENOVATION ASBESTOS CONTAINING MATERIAL SURVEY, LEAD BASED PAINT SURVEY, AND HAZARDOUS BUILDING MATERIAL INVENTORY



**Gwinnett Technical College Building 100 Renovation
Lawrenceville, Gwinnett County, Georgia**

PREPARED FOR:

Sizemore Group
342 Marietta Street, NW
Unit 3
Atlanta, Georgia 30313

NOVA Project Number: 3020091

August 14, 2020



August 14, 2020

Sizemore Group
342 Marietta Street, NW
Unit 3
Atlanta, Georgia 30313

Attention: Ms. Tulia Scott, AIA, NCARB, NOMA, LEED AP BD+C
Director of Architecture

Subject: Report of Pre-Renovation Asbestos Containing Material Survey,
Lead Based Paint Survey, and Hazardous Building Material Inventory
GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091

Ms. Scott:

NOVA Engineering and Environmental, LLC (NOVA) has completed the Pre-Renovation Asbestos Containing Material (ACM) Survey, Lead Based Paint (LBP) Survey, and Hazardous Building Material Inventory (HBMI) for the Gwinnett Technical College Building 100 Renovation located at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia. We appreciate your selection of NOVA and for the opportunity to be of service on this project. Please feel free to contact us if you have any questions or if we may be of further assistance.

Sincerely,
NOVA Engineering and Environmental, LLC

Curtis Moses
Staff Professional
Environmental Services
AHERA No. 17943
EPA Lead Inspector No. 1876

Nickolaus DaSantos
Business Unit Manager
Environmental Services
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APPENDIX D – QUALIFICATIONS OF CONCLUSIONS

1.0 SUMMARY

NOVA Engineering and Environmental, LLC. (NOVA) has completed the Pre-Renovation Asbestos Containing Material (ACM) Survey, Lead Based Paint (LBP) Survey, and Hazardous Building Material Inventory (HBMI) for the Gwinnett Technical College Building 100 Renovation located at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia (Subject Property). Field activities were performed on August 3, 2020.

A brief summary of our findings is presented below. This summary is provided for convenience and should not be substituted for review of the full report, including all attachments as provided herein.

1.1 ASBESTOS CONTAINING MATERIAL

During this study, seventy-four (74) samples (containing 109 total layers) of ceiling tile, floor tile, mastic, glue, caulking, joint compound, wallboard, ceiling tile, cove base, leveler, Thermal System Insulation (TSI), cement finish, grout, and mortar were analyzed by NOVA using Polarized Light Microscopy (PLM) with no analyzed samples indicating Asbestos Containing Material (ACM). A sample location plan is included in Appendix A of this Report.

No Asbestos Containing Material (ACM) was identified as during NOVA's on-site sampling program.

A complete list of suspected ACM samples obtained is shown in the laboratory report (included in Appendix B).

1.2 LEAD BASED PAINT & LEAD CONTAINING PAINT

Ninety-one (91) X-ray fluorescence (XRF) analyzer readings were made by NOVA throughout the interior and exterior of the Subject Property structure to determine the presence of Lead Based Paint (LBP).

Lead Based Paint

Lead Based Paint (LBP) is defined as a paint or varnish containing lead at a concentration >0.5% by weight when determined by laboratory analysis. LBP is also defined by HUD as 1.0 mg/cm² when determined using an XRF analyzer.

The predominant LBP material identified by the NOVA survey include

- Painted surfaces of drywall located at room 304A at the Subject Property.

Lead Containing Paint

OSHA does not define Lead Based Paint based on lead content. Any detectable lead in a paint or varnish makes it lead paint for purposes of complying with OSHA regulations to determine worker exposure. Consequently, for purposes of this study, Lead Containing Paint is considered any detectable level of lead.

The predominant LCP material identified by the NOVA survey include:

- Painted surfaces of concrete located at the Subject Property.

1.1 HAZARDOUS BUILDING MATERIAL

NOVA surveyed potential Hazardous Building Material (HBM) that was reasonably observed at the Subject Property. Potential HBM observed at the Subject Property include fire extinguishers, fluorescent lighting, ballasts, computers, monitors/ Liquid Crystal Display (LCD) screens, emergency exit signs, High Intensity Discharge (HID) lighting, thermostats, incandescent lighting, Light Emitting Diode (LED) fixtures, copier units/printers, Defibrillator unit, chemical vent hood, breaker box/panels, and miscellaneous facility cleaning/maintenance chemicals.

The names and locations of all the material identified in the HBMI are included in the table in Section 5.2 of this report.

2.0 INTRODUCTION

2.1 DESCRIPTION OF SUBJECT PROPERTY

The Subject Property is identified as the Gwinnett Technical College Building 100 Renovation located at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia (Subject Property). Specifically, the Subject Property includes rooms 201, 203, 205, 207, 209, 211, 217, 220, 400, 402, 402 C-1, the main covered entrance, southeast restroom, and the 200 hall as identified by Sizemore Group (Client).

2.2 PURPOSE

As requested by Sizemore Group (CLIENT), the Pre-Renovation Asbestos Containing Material Survey, Lead Based Paint Survey, and Hazardous Building Material Inventory (HBMI) was performed in an effort to identify Asbestos-Containing Material (ACM), Lead Based Paint (LBP), and Hazardous Building Material at the Subject Property. This work has been performed in general accordance with applicable state and federal regulations, and routine industry practice.

ACM sampling was performed in general accordance with the Asbestos Hazard Emergency Response Act (AHERA) guidelines and ASTM E2356-10, "Standard Practice for Comprehensive Building Asbestos Survey" as a Baseline Survey. Deviations from the Baseline Survey protocols include:

- Determination of ACM quantities were excluded from the scope of work

2.3 LIMITATIONS

NOVA has performed the Pre-Renovation Asbestos Containing Material Survey, Lead Based Paint Survey, and Hazardous Building Material Inventory (HBMI), which is a limited inquiry into a property's environmental status and is not sufficient to discover every potential source of ACM, LBP, or Hazardous Building Material (HBM) of the property to be evaluated. No survey/sampling can wholly eliminate uncertainty regarding the potential ACM, LBP, or HBM in connection with a property. Performance of this practice is intended to reduce, but not eliminate, uncertainty regarding the potential for ACM, LBP, and HBM in connection with a property.

The level of inquiry is variable. Not every property will warrant the same level of assessment for ACM, LBP, and HBM. Consistent with good commercial or customary practices, the appropriate level of assessment will be guided by the type of property subject to assessment, the intended use of the property, the expertise and risk tolerance of the CLIENT, and the information developed in the course of the assessment.

NOVA's findings, opinions, conclusions and recommendations are based on information obtained through visual assessment of surficial conditions in readily accessible areas. It is possible that additional ACM, LBP, or HBM exist or may subsequently become known that may impact or change the assessment after NOVA's services are complete.

NOVA's assessment represents our professional opinion, only. Therefore, NOVA cannot, under any circumstances, make a statement of warranty or guarantee, expressed or implied, that ACM, LBP, and HBM are limited to those that are discovered while we are performing the Sampling.

2.4 USER RELIANCE

NOVA's Pre-Renovation Asbestos Containing Material Survey, Lead Based Paint Survey, and Hazardous Building Material Inventory, along with the findings and conclusions contained in the report, either in completed form, summary form, or by extraction, is prepared, and intended, for the sole use of Sizemore Group (CLIENT) and therefore may not contain sufficient information for other purposes or parties. The CLIENT is the only intended beneficiary of this report. The contents of NOVA's report will continue to be the property of NOVA. NOVA's report may not be disclosed to, used by, or relied upon by, any person or entity other than the CLIENT without the express written consent of NOVA.

Authorization for disclosure to a third party or authorization for third-party reliance on a final report of any report will be considered by NOVA upon the written request of the CLIENT. NOVA reserves the right to deny authorization to allow disclosure or reliance of NOVA's report to third parties.

3.0 ASBESTOS CONTAINING MATERIAL

3.1 FIELD AND LABORATORY SERVICES

Mr. Curtis Moses, a NOVA professional and federal and state certified asbestos inspector, performed the field work for the Pre-Renovation Asbestos Containing Material Survey at the Subject Property on August 3, 2020.

3.1.1 ASBESTOS CONTAINING MATERIAL SAMPLING

The building area was visually assessed by NOVA to identify suspect ACM, which were then grouped into three categories according to their intended use:

- **Surfacing Material** such as sprayed-on or troweled fireproofing, acoustical and decorative insulation, textured “popcorn” finishes, paint, stucco, etc.
- **Thermal System Insulation (TSI)**, such as pipe, boiler and storage tank insulation, and insulation on ducts, pumps, heat exchangers, and other equipment.
- **Miscellaneous Material**, such as floor and ceiling tiles, wallboard, asbestos-cement board, siding and other building material that did not fall into one of the previously mentioned categories.

Where applicable, material with similar texture, color and general appearance were considered homogeneous for sampling purposes, including visually similar material on different floors. NOVA’s assessment also included touching representative samples to determine friability, a mechanical classification defined as whether a material can be crumbled, pulverized, or reduced to powder by hand pressure.

Bulk samples were subsequently obtained in general accordance with the AHERA (40 CFR 763.86, Sampling) and ASTM E2356-10 procedures. The samples were placed in appropriate containers, and the containers sealed and labeled with a unique identification number. The samples were subsequently transported (following routine industry practices and chain-of-custody procedures) to EMSL Analytical, LLC (EMSL) for analysis.

The ACM samples were analyzed for asbestos using Polarized Light Microscopy (PLM) methods in accordance with EPA Method 600/R-93/116. Copies of the complete asbestos laboratory report and chain-of custody are included in Appendix B.

Using the results of the laboratory analysis and NOVA’s visual assessment, the asbestos containing building material can be further categorized into three groups:

- **Friable ACM** - Material means any material containing more than one percent (1%) asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR part 763 Section 1, Polarized Light Microscopy, that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.
- **Category I Nonfriable ACM** - Asbestos-containing packing, gaskets, resilient floor covering, and asphalt roofing products containing more than one percent (1%) asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR part 763, Section 1, Polarized Light Microscopy.
- **Category II Nonfriable ACM** - Any material, excluding Category I Nonfriable ACM, containing more than one percent (1%) asbestos as determined using the methods specified in Appendix A, Subpart F, 40 CFR part 763, Section 1, Polarized Light Microscopy that, when dry, *cannot* be crumbled, pulverized, or reduced to powder by hand pressure.

During this study, seventy-four (74) samples (containing 109 total layers) of ceiling tile, floor tile, mastic, glue, caulking, joint compound, wallboard, ceiling tile, cove base, leveler, Thermal System Insulation (TSI), cement finish, grout, and mortar were analyzed by NOVA using Polarized Light Microscopy (PLM) with no analyzed samples indicating Asbestos Containing Material (ACM). A sample location plan is included in Appendix A of this Report.

No Asbestos Containing Material (ACM) was identified as during NOVA's on-site sampling program.

A complete list of suspected ACM samples obtained is shown in the laboratory report (included in Appendix B).

4.0 LEAD BASED PAINT & LEAD CONTAINING PAINT

4.1 DEFINITIONS

Lead Based Paint (LBP) is defined as a paint or varnish containing lead at a concentration $>0.5\%$ by weight when determined by laboratory analysis, (1972, Lead Based Paint Poison Prevention Act (LBPPPA)). LBP is also defined by HUD as 1.0 mg/cm^2 when determined using x-ray fluorescence (XRF) analyzer. These concentrations are applicable for housing and child-care facilities; however, these concentration levels are also frequently used as targets in commercial projects to allow flexibility in future area usage.

Lead Containing Paint (LCP) was defined as a paint or varnish containing lead at a concentration $>0.06\%$ by weight (600 ppm) when determined by laboratory analysis, (1978, LBPPPA). In 2009, LCP was further defined as containing lead at a concentration $>0.009\%$ by weight (90 ppm) for certain consumer products and residential use.

Please note that OSHA does not define Lead Based Paint based on lead content. Any detectable lead in a paint or varnish makes it lead paint for purposes of complying with OSHA regulations to determine worker exposure. Consequently, for purposes of this study, Lead Containing Paint is considered any detectable lead.

4.2 FIELD AND LABORATORY SERVICES

Mr. Curtis Moses, a NOVA professional and EPA certified lead inspector, performed the field work for the Lead Based Paint Survey at the Subject Property on August 3, 2020.

Ninety-one (91) X-ray fluorescence (XRF) analyzer readings were made by NOVA throughout the interior and exterior of the Subject Property structure to determine the presence of Lead Based Paint (LBP).

4.2.1 LEAD BASED PAINT SAMPLING

Where applicable, material with similar texture, color and general appearance were considered homogeneous for sampling purposes, including visually similar material on different floors and/or different buildings.

NOVA's XRF readings are presented below:

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
1	8/3/2020 12:58	cps							0.65	0
2	8/3/2020 13:01	mg / cm ^2						positive	1	0.1
3	8/3/2020 13:04	mg / cm ^2						positive	1	0.1

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
4	8/3/2020 13:08	mg / cm ^2						positive	1	0.1
5	8/3/2020 13:17	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
6	8/3/2020 13:17	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
7	8/3/2020 13:18	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
8	8/3/2020 13:19	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
9	8/3/2020 13:22	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
10	8/3/2020 13:23	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
11	8/3/2020 13:23	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
12	8/3/2020 13:26	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
13	8/3/2020 13:27	mg / cm ^2	beam	metal	C	intact	white	negative	<LOD	0.03
14	8/3/2020 13:28	mg / cm ^2	window	metal	C	intact	white	negative	<LOD	0.03
15	8/3/2020 13:30	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
16	8/3/2020 13:31	mg / cm ^2	trim	metal	D	intact	white	negative	<LOD	0.03
17	8/3/2020 13:33	mg / cm ^2	wall	concrete	D	intact	white	negative	<LOD	0.03
18	8/3/2020 13:34	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
19	8/3/2020 13:37	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
20	8/3/2020 13:38	mg / cm ^2	door	metal	D	intact	brown	negative	<LOD	0.03
21	8/3/2020 13:38	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
22	8/3/2020 13:39	mg / cm ^2	trim	metal	A	intact	white	negative	<LOD	0.03
23	8/3/2020 13:44	mg / cm ^2	door	metal	C	intact	brown	negative	<LOD	0.03
24	8/3/2020 13:45	mg / cm ^2	door	wood	C	intact	brown	negative	<LOD	0.03
25	8/3/2020 13:46	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
26	8/3/2020 13:46	mg / cm ^2	wall	drywall	C	intact	white	negative	<LOD	0.03
27	8/3/2020 13:47	mg / cm ^2	wall	drywall	B	intact	white	negative	<LOD	0.03
28	8/3/2020 13:47	mg / cm ^2	window	metal	B	intact	brown	negative	<LOD	0.03
29	8/3/2020 13:48	mg / cm ^2	wall	drywall	A	intact	white	positive	4.4	2.8
30	8/3/2020 13:49	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
31	8/3/2020 13:49	mg / cm ^2	wall	drywall	A	intact	white	positive	10.8	6.2
32	8/3/2020 13:50	mg / cm ^2	wall	drywall	A	intact	white	positive	11.2	6.6
33	8/3/2020 13:50	mg / cm ^2	wall	drywall	A	intact	white	positive	11.6	6.5
34	8/3/2020 13:50	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
35	8/3/2020 13:51	mg / cm ^2	wall	drywall	A	intact	white	positive	<LOD	14.7
36	8/3/2020 13:52	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
37	8/3/2020 13:53	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
38	8/3/2020 13:54	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
39	8/3/2020 13:55	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
40	8/3/2020 13:59	mg / cm ^2	wall	drywall	A	intact	black	negative	<LOD	0.03
41	8/3/2020 13:59	mg / cm ^2	wall	drywall	D	intact	black	negative	<LOD	0.03
42	8/3/2020 14:00	mg / cm ^2	wall	drywall	B	intact	black	negative	<LOD	0.03
43	8/3/2020 14:06	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
44	8/3/2020 14:07	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
45	8/3/2020 14:08	mg / cm ^2	wall	drywall	D	intact	white	negative	<LOD	0.03

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
46	8/3/2020 14:08	mg / cm ^2	door	metal	D	intact	blue	negative	<LOD	0.03
47	8/3/2020 14:09	mg / cm ^2	door	metal	D	intact	blue	negative	<LOD	0.03
48	8/3/2020 14:11	mg / cm ^2	column	metal	B	intact	white	negative	<LOD	0.03
49	8/3/2020 14:12	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
50	8/3/2020 14:12	mg / cm ^2	door	metal	A	intact	white	negative	<LOD	0.03
51	8/3/2020 14:13	mg / cm ^2	door	metal	A	intact	white	negative	<LOD	0.03
52	8/3/2020 14:15	mg / cm ^2	wall	concrete	A	intact	yellow	negative	<LOD	0.03
53	8/3/2020 14:16	mg / cm ^2	wall	concrete	D	intact	yellow	negative	<LOD	0.03
54	8/3/2020 14:16	mg / cm ^2	wall	drywall	C	intact	yellow	negative	<LOD	0.03
55	8/3/2020 14:18	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
56	8/3/2020 14:19	mg / cm ^2	door	metal	D	intact	white	negative	<LOD	0.03
57	8/3/2020 14:21	mg / cm ^2	door	metal	D	intact	brown	negative	<LOD	0.03
58	8/3/2020 14:22	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
59	8/3/2020 14:23	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
60	8/3/2020 14:24	mg / cm ^2	cabinet	wood	B	intact	white	negative	<LOD	0.03
61	8/3/2020 14:25	mg / cm ^2	wall	concrete	B	intact	brown	negative	<LOD	0.03
62	8/3/2020 14:26	mg / cm ^2	wall	concrete	B	intact	brown	negative	<LOD	0.05
63	8/3/2020 14:28	mg / cm ^2	floor	concrete	A	intact	brown	negative	<LOD	0.03
64	8/3/2020 14:28	mg / cm ^2	floor	concrete	A	intact	brown	negative	<LOD	0.03
65	8/3/2020 14:31	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
66	8/3/2020 14:31	mg / cm ^2	wall	concrete	D	intact	white	negative	<LOD	0.03
67	8/3/2020 14:32	mg / cm ^2	wall	drywall	D	intact	white	negative	<LOD	0.03
68	8/3/2020 14:33	mg / cm ^2	wall	drywall	D	intact	white	negative	<LOD	0.03
69	8/3/2020 14:34	mg / cm ^2	wall	drywall	C	intact	green	negative	<LOD	0.03
70	8/3/2020 14:34	mg / cm ^2	door	metal	B	intact	white	negative	<LOD	0.03
71	8/3/2020 14:35	mg / cm ^2	door	metal	B	intact	white	negative	<LOD	0.03
72	8/3/2020 14:35	mg / cm ^2	wall	drywall	B	intact	red	negative	<LOD	0.03
73	8/3/2020 14:41	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
74	8/3/2020 14:41	mg / cm ^2	wall	wood	D	intact	white	negative	<LOD	0.03
75	8/3/2020 14:42	mg / cm ^2	wall	wood	D	intact	white	negative	<LOD	0.03
76	8/3/2020 14:42	mg / cm ^2	wall	wood	A	intact	brown	negative	<LOD	0.03
77	8/3/2020 14:43	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
78	8/3/2020 14:47	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
79	8/3/2020 14:47	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
80	8/3/2020 14:48	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.07
81	8/3/2020 14:48	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.12
82	8/3/2020 14:49	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.45
83	8/3/2020 14:50	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
84	8/3/2020 14:52	mg / cm ^2	wall	concrete	A	intact	yellow	negative	<LOD	0.03
85	8/3/2020 14:52	mg / cm ^2	column	metal	A	intact	yellow	negative	<LOD	0.03
86	8/3/2020 14:54	mg / cm ^2	floor	ceramic	A	intact	brown	negative	<LOD	0.03
87	8/3/2020 15:09	mg / cm ^2	door	metal	A	intact	blue	negative	<LOD	0.03

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
88	8/3/2020 15:10	mg / cm ^2	door	metal	A	intact	blue	negative	<LOD	0.03
89	8/3/2020 15:18	mg / cm ^2						positive	1	0.1
90	8/3/2020 15:18	mg / cm ^2						positive	1	0.1
91	8/3/2020 15:22	mg / cm ^2						positive	0.9	0.1

< LOD = below level of detection

Lead Based Paint

Lead Based Paint (LBP) is defined as a paint or varnish containing lead at a concentration >0.5% by weight when determined by laboratory analysis. LBP is also defined by HUD as 1.0 mg/cm² when determined using an XRF analyzer.

The predominant LBP material identified by the NOVA survey include

- Painted surfaces of drywall located at room 304A at the Subject Property.

Lead Containing Paint

OSHA does not define Lead Based Paint based on lead content. Any detectable lead in a paint or varnish makes it lead paint for purposes of complying with OSHA regulations to determine worker exposure. Consequently, for purposes of this study, Lead Containing Paint is considered any detectable level of lead.

The predominant LCP material identified by the NOVA survey include:

- Painted surfaces of concrete located at the Subject Property.

5.0 HAZARDOUS BUILDING MATERIAL INVENTORY

5.1 FIELD SERVICES

Mr. Curtis Moses, a NOVA Professional, performed the field work for the Hazardous Building Material Inventory (HBMI) for the Subject Property on August 3, 2020.

5.2 HAZARDOUS BUILDING MATERIAL INVENTORY

NOVA surveyed potential Hazardous Building Material (HBM) that was reasonably observed at the Subject Property. Potential HBM observed at the Subject Property include fire extinguishers, fluorescent lighting, ballasts, computers, monitors/Liquid Crystal Display (LCD) screens, emergency exit signs, High Intensity Discharge (HID) lighting, thermostats, incandescent lighting, Light Emitting Diode (LED) fixtures, copier units/printers, Defibrillator unit, chemical vent hood, breaker box/panels, and miscellaneous facility cleaning/maintenance chemicals.

The materials identified are listed below:

SUMMARY OF HAZARDOUS BUILDING MATERIAL FINDINGS

MATERIAL / EQUIPMENT	LOCATION	ESTIMATED QUANTITY
Fire extinguishers	Throughout	8
Fluorescent Light Bulbs 4'	Throughout	640
Fluorescent Light Bulbs 2'	Hallways & Common Areas	94
Fluorescent Light Ballasts 4'	Throughout	358
Fluorescent Light Ballasts 2'	Hallways & Common Areas	45
Computers	Storage & Offices	417
Emergency Exit Signs	Throughout	17
HID Lighting	Throughout	30
Thermostats (Electric)	Throughout	17
Incandescent Lighting	Restroom & Storage	25
Monitors/LCD Screens	Storage & Offices	210
LED Lighting	Common Areas	40
Copier Units/Printers	Storage & Offices	32
Defibrillator	Hallway	1
Breaker Box/Panels	Mechanical Rooms	4
Chemical Vent Hood	Science Department	1
Refrigerators/Machines	Throughout	5

Additionally, small batteries, and chemicals associated with cleaning/maintenance were observed throughout the facility.

It should be noted that the above list is an approximation of what was observed by NOVA at the time of the site reconnaissance.

Based on the findings of random checks, the majority of ballasts at the Subject Property are labeled as “Non-PCB” containing. Ballasts that are not labeled as Non-PCB containing should be assumed to be PCB-containing. Some thermostats are mercury-containing. Emergency exit signs and exit lighting units are assumed to contain nickel-cadmium batteries.

Electronic equipment such as cell phones, smoke detectors, laptop computers can contain batteries. Additional batteries are stored throughout the building and likely associated with the fire, emergency lighting, and security alarm systems. These batteries should be disposed in accordance with applicable regulations.

5.3 HAZARDOUS BUILDING MATERIAL INVENTORY CONCLUSIONS

NOVA surveyed potential Hazardous Building Material (HBM) that was reasonably observed at the Subject Property. Potential HBM observed at the Subject Property include incandescent lighting, fluorescent lighting, ballasts, High Intensity Discharge (HID) lighting, Light Emitting Diode (LED), emergency exit signs, fire extinguishers, air handler and HVAC units, hydraulic fluid, transformers, computer equipment, and miscellaneous facility cleaning/maintenance chemicals.

The removal and proper disposal of the HBM identified within this report should be managed in accordance with the following rules:

- Solid Waste Management – Georgia Environmental Rule 391-3-4
- Hazardous Waste Management – Georgia Environmental Rule 391-3-11

Batteries: All batteries should be removed from equipment and transported for recycling in accordance with applicable regulations. Additional batteries likely associated with the security, emergency lighting, and fire warning systems should be disposed properly.

PCB-Containing Ballasts: Ballasts should be removed and disposed in accordance with 40 CFR 761.62 and all other applicable regulations.

Fluorescent and Incandescent Light Bulbs: Bulbs should be disposed in accordance with Resource Conservation & Recovery Act (RCRA):

- Subtitle C: Hazardous Waste (40 CFR Parts 261, 262), or if found to be non-hazardous;
- Subtitle D: Municipal & Other Non-Hazardous Waste (40 CFR 258).

Chemical Waste: All chemicals, including cleaning/maintenance chemicals, should be removed, transported and disposed in accordance with applicable regulations.

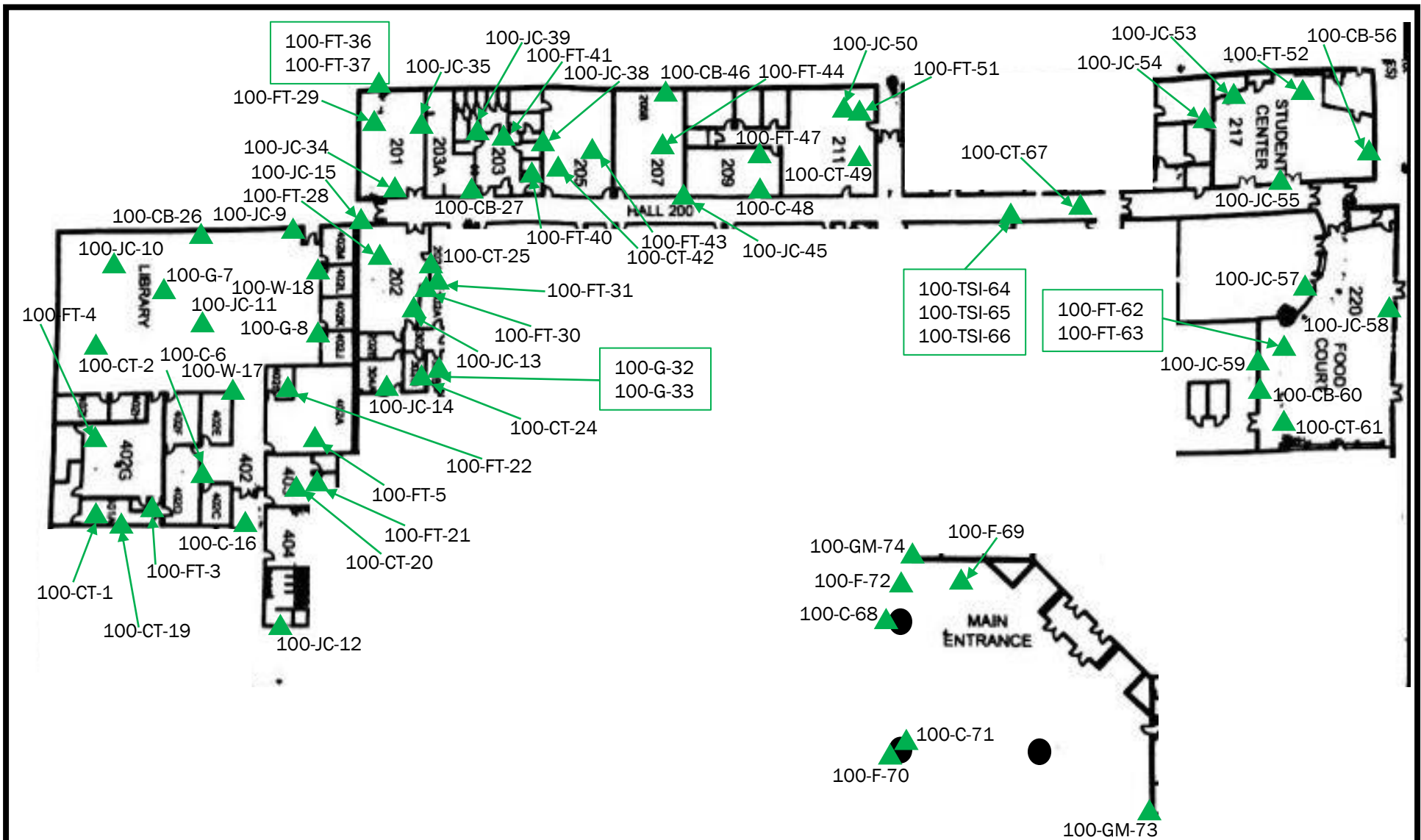
Fire Extinguishers: All chemical containing fire extinguishers should be removed, transported and disposed in accordance with applicable regulations.



High-Intensity-Discharge (HID) Lighting & Light Emitting Diode (LED) Lighting: Should be disposed in accordance with the federal Universal Waste Rule (see 40 CFR 273).

Electronic devices: Computer monitors, computer hard drives, printers, telephones, refrigerators, LED lighting, thermostats, and microwave ovens can contain chemicals such as lead, cadmium, chromium, mercury and copper. Caution should be used during the removal of these devices, and they should be disposed in accordance with applicable regulations.

APPENDIX A

SAMPLE LOCATION PLANS
&
SITE PHOTOGRAPHS



 Asbestos Containing Material
 Non-Asbestos Containing Material

SAMPLE LOCATION PLAN



SIZEMORE GROUP
 GWINNETT TECHNICAL COLLEGE
 BUILDING 100 RENOVATION
 LAWRENCEVILLE, GWINNETT COUNTY, GEORGIA
 NOVA Project Number 3020091



- Lead Based Paint
- Lead Containing Paint
- Non-Detect

SAMPLE LOCATION PLAN



SIZEMORE GROUP
GWINNETT TECHNICAL COLLEGE
BUILDING 100 RENOVATION
 LAWRENCEVILLE, GWINNETT COUNTY, GEORGIA
 NOVA Project Number 3020091

GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091



Photograph 1: Typical view of the Fluorescent light ballasts located at the Subject Property.



Photograph 2: Additional view of the fluorescent lighting located at the Subject Property.

GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091



Photograph 3: Typical view of the emergency exit signs located at the Subject Property.



Photograph 4: Typical view of the High Intensity Discharge (HID) lighting located at the Subject Property.

GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091



Photograph 5: Typical view of the thermostats located at the Subject Property.



Photograph 6: View of the defibrillator located in the hallway at the Subject Property.

GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091



Photograph 7: Typical view of the panels/breakers located at the Subject Property.



Photograph 8: Typical view of fire extinguishers located at the Subject Property.

GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091



Photograph 9: Typical view of the chemical vent hood located at the Subject Property.



Photograph 10: Typical view of the refrigerators located at the Subject Property.

GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091



Photograph 11: Typical view of monitors/LCD screens & computers located at the Subject Property.



Photograph 12: Typical view of the copier units & printers located at the Subject Property.

APPENDIX B

LABORATORY ANALYTICAL DATA



EMSL Analytical, Inc.

2205 Corporate Plaza Parkway SE, Suite 200 Smyrna, GA 30080

Tel/Fax: (770) 956-9150 / (770) 956-9181

<http://www.EMSL.com> / atlantalab@emsl.com

EMSL Order: 072005313

Customer ID: NOVA30

Customer PO: 3020091

Project ID:

Attention: Curtis Moses
Nova Engineering & Environmental, Inc.
3900 Kennesaw 75 Parkway
Suite 100
Kennesaw, GA 30144

Phone: (678) 982-5576

Fax: (770) 425-1113

Received Date: 08/03/2020 5:00 PM

Analysis Date: 08/04/2020 - 08/05/2020

Collected Date:

Project: 3020091

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
100-CT-1 <small>072005313-0001</small>	Ceiling Tile - 2 x 4 Line - 402 C-1	Gray Fibrous Homogeneous	60% Cellulose 5% Min. Wool	35% Non-fibrous (Other)	None Detected
100-CT-2 <small>072005313-0002</small>	Ceiling Tile - 2 x 4 Line - 402	Gray Fibrous Homogeneous	60% Cellulose 5% Min. Wool	35% Non-fibrous (Other)	None Detected
100-FT-3-Floor Tile <small>072005313-0003</small>	12 x 12 Grey w/ Glue - 402 C-1	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-3-Mastic <small>072005313-0003A</small>	12 x 12 Grey w/ Glue - 402 C-1	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-4-Floor Tile <small>072005313-0004</small>	12 x 12 Grey w/ Glue - 402	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-4-Mastic <small>072005313-0004A</small>	12 x 12 Grey w/ Glue - 402	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-5-Floor Tile <small>072005313-0005</small>	Grey Floor Tile w/ Glue	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-5-Mastic <small>072005313-0005A</small>	Grey Floor Tile w/ Glue	Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-C-6 <small>072005313-0006</small>	Door Frame Caulking - 4020	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-G-7 <small>072005313-0007</small>	Carpet Glue - Library	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-G-8 <small>072005313-0008</small>	Carpet Glue - Library	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-9 <small>072005313-0009</small>	Joint Compound - Library - End	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-10 <small>072005313-0010</small>	Joint Compound - Library - CFT	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-11 <small>072005313-0011</small>	Joint Compound - Library - Ceiling	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-12 <small>072005313-0012</small>	Joint Compound - Restroom	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-13 <small>072005313-0013</small>	Joint Compound - 202	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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EMSL Order: 072005313

Customer ID: NOVA30

Customer PO: 3020091

Project ID:

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
100-JC-14 <small>072005313-0014</small>	Joint Compound - 302	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-15 <small>072005313-0015</small>	Joint Compound - 201	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-C-16 <small>072005313-0016</small>	Caulking - Library Frame	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-W-17 <small>072005313-0017</small>	Wallboard - Library	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-W-18 <small>072005313-0018</small>	Wallboard - Library	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CT-19 <small>072005313-0019</small>	2 x 4 Ceiling Tile - Mech - 402a	Gray Fibrous Homogeneous	60% Cellulose 10% Min. Wool	30% Non-fibrous (Other)	None Detected
100-CT-20 <small>072005313-0020</small>	2 x 4 Ceiling Tile - Mech - 403	Gray Fibrous Homogeneous	60% Cellulose 10% Min. Wool	30% Non-fibrous (Other)	None Detected
100-FT-21-Floor Tile <small>072005313-0021</small>	Flat Tan 12x12 w/ Glue - 403	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-21-Mastic <small>072005313-0021A</small>	Flat Tan 12x12 w/ Glue - 403	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-22-Floor Tile <small>072005313-0022</small>	Flat Tan 12x12 w/ Glue - 403a	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-22-Mastic <small>072005313-0022A</small>	Flat Tan 12x12 w/ Glue - 403a	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CT-24 <small>072005313-0023</small>	Ceiling Tile - 302D - 2x2	Gray Fibrous Homogeneous	60% Cellulose 5% Min. Wool	35% Non-fibrous (Other)	None Detected
100-CT-25 <small>072005313-0024</small>	Ceiling Tile - 302B - 2x2	Gray Fibrous Homogeneous	60% Cellulose 5% Min. Wool	35% Non-fibrous (Other)	None Detected
100-CB-26-Gray layer <small>072005313-0025</small>	Cove Base Glue - Library	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-26-Yellow layer <small>072005313-0025A</small>	Cove Base Glue - Library	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-27-Gray layer <small>072005313-0026</small>	Cove Base Glue - 203	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-27-Yellow layer <small>072005313-0026A</small>	Cove Base Glue - 203	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-28-Floor Tile <small>072005313-0027</small>	Floor Tile 12x12 - Grey Dot - 202	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-28-Mastic <small>072005313-0027A</small>	Floor Tile 12x12 - Grey Dot - 202	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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Project ID:

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Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
100-FT-29-Floor Tile <small>072005313-0028</small>	Floor Tile 12x12 - Grey Dot - 202	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-29-Mastic <small>072005313-0028A</small>	Floor Tile 12x12 - Grey Dot - 202	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-30-Floor Tile <small>072005313-0029</small>	Floor Tile 12x12 - Multi - 202	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-30-Mastic <small>072005313-0029A</small>	Floor Tile 12x12 - Multi - 202	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-31-Floor Tile <small>072005313-0030</small>	Floor Tile 12x12 - Multi - 202	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-31-Mastic <small>072005313-0030A</small>	Floor Tile 12x12 - Multi - 202	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-G-32 <small>072005313-0031</small>	Glue - Carpet - 202	Green Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-G-33 <small>072005313-0032</small>	Glue - Carpet - 202	Green Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-34-Joint Compound <small>072005313-0033</small>	Joint Compound w/ Cove Base Glue 201	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-34-Glue <small>072005313-0033A</small>	Joint Compound w/ Cove Base Glue 201	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-35 <small>072005313-0034</small>	Joint Compound - Wall - 201	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-36-Floor Tile <small>072005313-0035</small>	12x12 Glue - Blue - w/ Glue - 201	Blue Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-36-Mastic <small>072005313-0035A</small>	12x12 Glue - Blue - w/ Glue - 201	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-37-Floor Tile <small>072005313-0036</small>	12x12 Glue - Blue - w/ Glue - 201	Blue Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-37-Mastic <small>072005313-0036A</small>	12x12 Glue - Blue - w/ Glue - 201	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-38 <small>072005313-0037</small>	Joint Compound - 203	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-39 <small>072005313-0038</small>	Joint Compound - 203A	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-40-Floor Tile <small>072005313-0039</small>	FT - 12x12 w/ Glue - White - 203 Closet	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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Customer ID: NOVA30
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Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
100-FT-40-Mastic <small>072005313-0039A</small>	FT - 12x12 w/ Glue - White - 203 Closet	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-41-Floor Tile <small>072005313-0040</small>	FT - 12x12 w/ Glue - White - Main	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-41-Mastic 1 <small>072005313-0040A</small>	FT - 12x12 w/ Glue - White - Main	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-41-Mastic 2 <small>072005313-0040B</small>	FT - 12x12 w/ Glue - White - Main	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CT-42 <small>072005313-0041</small>	Ceiling Tile - 205 - 2x4	Gray Fibrous Homogeneous	60% Cellulose 10% Min. Wool	30% Non-fibrous (Other)	None Detected
100-FT-43-Floor Tile <small>072005313-0042</small>	Tan Tile w/ Mastic - 205	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-43-Mastic 1 <small>072005313-0042A</small>	Tan Tile w/ Mastic - 205	Black Non-Fibrous Homogeneous	3% Cellulose	97% Non-fibrous (Other)	None Detected
100-FT-43-Mastic 2 <small>072005313-0042B</small>	Tan Tile w/ Mastic - 205	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-44-Floor Tile <small>072005313-0043</small>	Tan Tile w/ Mastic - 12x12 Tile - 207	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-44-Mastic 1 <small>072005313-0043A</small>	Tan Tile w/ Mastic - 12x12 Tile - 207	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-44-Mastic 2 <small>072005313-0043B</small>	Tan Tile w/ Mastic - 12x12 Tile - 207	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-45-Joint Compound <small>072005313-0044</small>	Joint Compound - At Hall 207	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-45-Drywall <small>072005313-0044A</small>	Joint Compound - At Hall 207	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-46-Cove Base <small>072005313-0045</small>	Cove Base Glue - At All 207	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-46-Glue <small>072005313-0045A</small>	Cove Base Glue - At All 207	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-47-Floor Tile <small>072005313-0046</small>	Tan / White 12x12 w/ Mastic 209	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-47-Mastic <small>072005313-0046A</small>	Tan / White 12x12 w/ Mastic 209	Black Non-Fibrous Homogeneous	3% Cellulose	97% Non-fibrous (Other)	None Detected
100-C-48 <small>072005313-0047</small>	Door Frame Caulking 209	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CT-49 <small>072005313-0048</small>	Ceiling Tile 2x4 - 211	Gray Fibrous Homogeneous	60% Cellulose 10% Min. Wool	30% Non-fibrous (Other)	None Detected

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Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
100-JC-50 <i>072005313-0049</i>	Carpet Glue	Yellow Fibrous Homogeneous	5% Synthetic	95% Non-fibrous (Other)	None Detected
100-FT-51-Floor Tile <i>072005313-0050</i>	12x12 White w/ Glue - Lab 211	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-51-Mastic <i>072005313-0050A</i>	12x12 White w/ Glue - Lab 211	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-51-Leveler <i>072005313-0050B</i>	12x12 White w/ Glue - Lab 211	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-52-Floor Tile <i>072005313-0051</i>	Carpet Glue - Store And 12 x 12 Grey Store	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-52-Mastic 1 <i>072005313-0051A</i>	Carpet Glue - Store And 12 x 12 Grey Store	Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-52-Mastic 2 <i>072005313-0051B</i>	Carpet Glue - Store And 12 x 12 Grey Store	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-53 <i>072005313-0052</i>	Store - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-54 <i>072005313-0053</i>	Store - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-55 <i>072005313-0054</i>	Store - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-56-Cove Base <i>072005313-0055</i>	Cove Base Glue - Front - Store	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-56-Glue <i>072005313-0055A</i>	Cove Base Glue - Front - Store	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-57 <i>072005313-0056</i>	Joint Compound - 220A	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-58 <i>072005313-0057</i>	Joint Compound - 220	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-JC-59 <i>072005313-0058</i>	Joint Compound - 220	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-60-Cove Base <i>072005313-0059</i>	Cove Base Glue - 220	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CB-60-Glue <i>072005313-0059A</i>	Cove Base Glue - 220	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-CT-61 <i>072005313-0060</i>	CT - 12x12 w/ Glue - 220	Gray Fibrous Homogeneous	60% Cellulose 5% Min. Wool	35% Non-fibrous (Other)	None Detected
100-FT-62-Floor Tile 1 <i>072005313-0061</i>	Yellow/Black 12 x 12 w/ Glue - 220	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
100-FT-62-Mastic 1 <small>072005313-0061A</small>	Yellow/Black 12 x 12 w/ Glue - 220	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-62-Floor Tile 2 <small>072005313-0061B</small>	Yellow/Black 12 x 12 w/ Glue - 220	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-62-Mastic 2 <small>072005313-0061C</small>	Yellow/Black 12 x 12 w/ Glue - 220	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-63-Floor Tile <small>072005313-0062</small>	Yellow/Black 12 x 12 w/ Glue - 220	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-63-Mastic 1 <small>072005313-0062A</small>	Yellow/Black 12 x 12 w/ Glue - 220	Clear Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-FT-63-Mastic 2 <small>072005313-0062B</small>	Yellow/Black 12 x 12 w/ Glue - 220	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-TSI-64 <small>072005313-0063</small>	TSI-Run Hallway - 200 Hall	Various Fibrous Homogeneous	70% Cellulose 10% Glass	20% Non-fibrous (Other)	None Detected
100-TSI-65 <small>072005313-0064</small>	TSI-Run Hallway - 200 Hall	Various Fibrous Homogeneous	70% Cellulose 10% Glass	20% Non-fibrous (Other)	None Detected
100-TSI-66 <small>072005313-0065</small>	TSI-Run Hallway - 200 Hall	Various Fibrous Homogeneous	70% Cellulose 10% Glass	20% Non-fibrous (Other)	None Detected
100-CT-67 <small>072005313-0066</small>	CT - 2x2 - Flat - 200 Hall	Gray Non-Fibrous Homogeneous	60% Cellulose	40% Non-fibrous (Other)	None Detected
100-C-68-Gray layer <small>072005313-0067</small>	Caulking - Column Base	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-C-68-Yellow layer <small>072005313-0067A</small>	Caulking - Column Base	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-F-69 <small>072005313-0068</small>	Cement Finish - Ceiling	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-F-70 <small>072005313-0069</small>	Cement Finish - Side	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-C-71 <small>072005313-0070</small>	Caulking - Column - Side - Joint	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-F-72 <small>072005313-0071</small>	Cement Finish - Side	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-GM-73 <small>072005313-0072</small>	Grout / Mortar - Block Walls - Offices	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
100-GM-74 <small>072005313-0073</small>	Grout / Mortar - Block Walls - Halls	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

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Analyst(s)

Anthony Sanaie (109)

Michael Murphy
or Other Approved Signatory

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Samples analyzed by EMSL Analytical, Inc Smyrna, GA NVLAP Lab Code 101048-1

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EMSL ANALYTICAL, INC.
LABORATORY PRODUCTS TRAINING

Asbestos Chain of Custody

EMSL Order Number *(lab use only)*:

072005313

EMSL ANALYTICAL, INC.
2205 CORPORATE PLAZA PKWY
SMYRNA, GA 30080
PHONE: (770) 956-9150
FAX

Company Name: NOVA		EMSL Customer ID: NOVA 3C	
Street: 3900 Kennesaw 75 Phwy		City: Kennesaw	State or Province:
Zip/Postal Code: 30144	Country:	Telephone #: (770) 425-0777	Fax #:
Report To (Name): CM-ND		Please Provide Results via: <input type="checkbox"/> Fax <input checked="" type="checkbox"/> Email	
email Address: CM-ND		Purchase Order Number:	
Client Project ID: 3020091		EMSL Project ID <i>(internal use only)</i> :	
State or Province Collected:		CT only <input type="checkbox"/> Commercial/Taxable <input type="checkbox"/> Residential <input checked="" type="checkbox"/> Tax Exempt	

EMSL-Bill to: Same Different - *If bill to is different note instructions in comment Third party billing requires written authorization from third party**

Turnaround Time (TAT) Options Please Check

3 Hr¹ 4-4.5 Hr¹ AHERA Only 6 Hr¹ 24 Hr 32 Hr² 48 Hr 72 Hr 96 Hr 1 Week 2 Week

¹Premium Service Charge applies for 3 Hour TEM AHERA or EPA Level II TAT - you will be asked to sign an authorization form TEM Air 3-6 Hour, please call ahead to schedule
²32 Hour TAT available for select tests only, samples must be submitted by 11.30am.

PCM - Air <input type="checkbox"/> NIOSH 7400 <input type="checkbox"/> w/ OSHA 8hr. TWA PLM - Bulk (reporting limit) <input checked="" type="checkbox"/> PLM EPA 600/R-93/116 (<1%) <input type="checkbox"/> PLM EPA NOB Point Count (<1%) Point Count <input type="checkbox"/> 400 (<0.25%) <input type="checkbox"/> 1000 (<0.1%) Point Count w/Gravimetric <input type="checkbox"/> 400 (<0.25%) <input type="checkbox"/> 1000 (<0.1%) <input type="checkbox"/> NYS 198.1 (friable - NY) <input type="checkbox"/> NYS 198.6 NOB (non-friable-NY) <input type="checkbox"/> NYS 198.8 SOF-V <input type="checkbox"/> NIOSH 9002 (<1%)	TEM - Air¹ <input type="checkbox"/> AHERA 40 CFR, Part 763 <input type="checkbox"/> NIOSH 7402 <input type="checkbox"/> EPA Level II <input type="checkbox"/> ISO 10312 TEM - Bulk <input type="checkbox"/> TEM EPA NOB <input type="checkbox"/> NYS NOB 198 4 (non-friable-NY) <input type="checkbox"/> TEM EPA 600/R-93/116 with milling prep (<0.1%) TEM - Water: EPA 100.2 Fibers >10µm <input type="checkbox"/> Waste <input type="checkbox"/> Drinking All Fiber Sizes <input type="checkbox"/> Waste <input type="checkbox"/> Drinking	TEM - Settled Dust <input type="checkbox"/> Microvac - ASTM D 5755 <input type="checkbox"/> Wipe - ASTM D6480 <input type="checkbox"/> Carpet Sonication (EPA 600/J-93/167) Soil - Rock - Vermiculite (reporting limit) <input type="checkbox"/> PLM EPA 600/R-93/116 with milling prep (<0.25%) <input type="checkbox"/> TEM EPA 600/R-93/116 with milling prep (<0.1%) <input type="checkbox"/> TEM Qualitative via Filtration Prep. <input type="checkbox"/> TEM Qualitative via Drop Mount Prep <input type="checkbox"/> Cincinnati Method EPA 600/R-04/004 - PLM/TEM. <i>Lower reporting limits available on request</i> Other test (please specify):
--	--	--

Stop At First Positive *(clearly identify homogenous areas below)* Filter Pore Size (Air Samples): 0.8µm 0.45µm

Sampler's Name: **C.M.** Sampler's Signature:

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
✓ 100-CT-1	Ceiling Tile - 2x4 - Line	402 C-1	
✓ 100-CT-2	↓ ↓	402	
✓ 100-F7-3	12x12 Grey Seta w/Glue	402 C-1	
✓ 100-F7-4	↓ ↓	402	
✓ 100-F7-5	Grey Floor Tile w/Glue		

Client Sample # (s): **1-72** Total # of Samples: **1-(72)**

Relinquished by (Client): Date: **8-3-2020** Time: **5:00 pm**

Received by (Lab): **SP** Date: **8/3/2020** Time: **5:00 DB**

Comments/Special Instructions:
Glue dots - mirrors
Vent Hood
75 49
29 50



EMSL ANALYTICAL, INC.
LABORATORY • PRODUCTS • TRAINING

Asbestos Chain of Custody

EMSL Order Number (Lab Use Only)

EMSL ANALYTICAL, INC.
200 ROUTE 130 NORTH
CINNAMINSON, NJ 08077
PHONE: (800) 220-3675
FAX: (856) 786-5974

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
✓ 100-C-6	Pool Frame Ceiling - 4020		
✓ 100-G-7	Carpet Glue - Library		
✓ 100-G-8	↓ - ↓		
✓ 100-SC-9	Joint Compound - Library - End		
✓ 100-SC-10	- ↓ Ctr		
✓ 100-SC-11	- ↓ Ceiling		
✓ 100-SC-12	- Restroom	1	
✓ 100-SC-13	- 202		
✓ 100-SC-14	- 302		
✓ 100-SC-15	↓ - 201		
✓ 100-C-16	Ceiling - Library Frame		
✓ 100-W-17	Wallboard - Library		
✓ 100-W-18	↓ -		
✓ 100-CT-19	2x4 Ceiling Tile - mech - 402a		
✓ 100-CT-20	↓ ↓ 403		
✓ 100-FT-21	Flat Tan 12x12 w Glue - 403		
✓ 100-FT-22	↓ - 403a		
✓ 100-CT-24	Ceiling Tile - 302D - 2x2		
✓ 100-CT-25	- 202B - 2x2		
✓ 100-CB-26	Carpet Glue - Library		
✓ 100-CB-27	↓ 203		

*Comments/Special Instructions:

EMSL ANALYTICAL, INC.
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Asbestos Chain of Custody

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200 ROUTE 130 NOR.
CINNAMINSON, NJ 08077
PHONE: (800) 220-3675
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Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
✓ 100-F7-28	Floor Tile - 12x12 - Grey dot - 202		
✓ 100-F7-29	↓ - ↓	↓	
✓ 100-F7-30	↓ - multi	↓	
✓ 100-F7-31	↓ - ↓	↓	
✓ 100-G-32	Blue - Carpet - 202		
✓ 100-S-33	↓ ↓		
✓ 100-IC-34	Joint Compound w/ cov base Blue 202		
✓ 100-3C-35	↓ - wall - 201		
✓ 100-F7-36	12x12 Blue - Blue - w/Blue - 201		
✓ 100-F7-37	↓	↓	
✓ 100-3C-38	Joint Compound -	203	
✓ 100-3C-39	↓ -	203A	
✓ 100-F7-40	F7 - 12x12 w/Blue - white	205 closet	
✓ 100-F7-41	↓ ↓	main	
✓ 100-C7-42	Ceiling Tile - 205 - 2x4		
✓ 100-F7-43	Tan Tile w/ Mastic	205	
✓ 100-F7-44	Tan/white w/ mastic 12x12 tile	207	
✓ 100-3C-45	Joint Compound - at Hall	207	
✓ 100-CB-46	Covebase Blue - at Hall	207	
✓ 100-F7-47	Tan/white 12x12 w/ mastic	209	
✓ 100-C-48	Door Frame Caulking	209	

*Comments/Special Instructions:

Page 3 of 5 pages



EMSL ANALYTICAL, INC.
LABORATORY PRODUCTS TRAINING

Asbestos Chain of Custody
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200 ROUTE 130 NORTH
CINNAMINSON, NJ 08077
PHONE (800) 220-3675
FAX (856) 786-5974

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
✓ 100-CT-49	Ceiling Tile 2x4	2A	
NOTE-	Vent Hood		
✓ 100-3C-50	Joint Compound - 2H Wall Carpet Glue		
✓ 100-FT-51	12x12 white w/Glue - Lab	2A	
✓ 100- FT -52	Carpet Glue - Store and 12x12 Grey		Store
✓ 100-3C-53	Store - Joint Compound		
✓ 100-3C-54	↓		
✓ 100-3C-55	↓		
✓ 100-CB-56	Cove base Glue - Front - Store		
✓ 100-X-57	Joint Compound - 220A		
✓ 100-3C-58	↓ - 220		
✓ 100-3C-59	↓ - 220		
✓ 100-CB-60	Cove base Glue - 220		
✓ 100-CT-61	CT - 2x2 - Flat - 220		
✓ 100-FT-62	Yellow/Black 12x12 w/Glue -	220	
✓ 100-FT-63	↓ ↓	220	
✓ 100-TSL-64	75I - Run Hallway - Tachon	200 200	Hall
✓ 100-TSL-65	↓ ↓ ↓		
✓ 100-TSL-66	↓ ↓ ↓		
✓ 100-CT-67	CT - 2x2 - Flat - 200 Hall		

*Comments/Special Instructions:



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Asbestos Chain of Custody

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200 ROUTE 130 NORTH
CINNAMINSON, NJ 08077

PHONE: (800) 220-3675

FAX: (856) 786-5974

Additional pages of the Chain of Custody are only necessary if needed for additional sample information

Sample #	Sample Description/Location	Volume, Area or Homogenous Area	Date/Time Sampled
✓ 100-C-68	Caulking - Column Base ^{Base}		
✓ 100-F-69	Cement Finish - Ceiling		
✓ 100-F-70	↓ - Side		
✓ 100-C-71	Caulking - Column - Side Joint		
✓ 100-F-72	Cement Finish - Side		
100-GM-73	Grout/mortar - Block walls - offices		
100-GM-74	↓ ↓ - Halls		

*Comments/Special Instructions:



Document - COC-05 Asbestos - R12 - 09/03/2019

EMSL Analytical, Inc's (DBA: LA Testing) Laboratory Terms and Conditions are incorporated into this chain of custody by reference in their entirety. Submission of samples to EMSL Analytical Inc. constitutes acceptance and acknowledgment of all terms and conditions.

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
1	8/3/2020 12:58	cps							0.65	0
2	8/3/2020 13:01	mg / cm ^2						positive	1	0.1
3	8/3/2020 13:04	mg / cm ^2						positive	1	0.1
4	8/3/2020 13:08	mg / cm ^2						positive	1	0.1
5	8/3/2020 13:17	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
6	8/3/2020 13:17	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
7	8/3/2020 13:18	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
8	8/3/2020 13:19	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
9	8/3/2020 13:22	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
10	8/3/2020 13:23	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
11	8/3/2020 13:23	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
12	8/3/2020 13:26	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
13	8/3/2020 13:27	mg / cm ^2	beam	metal	C	intact	white	negative	<LOD	0.03
14	8/3/2020 13:28	mg / cm ^2	window	metal	C	intact	white	negative	<LOD	0.03
15	8/3/2020 13:30	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
16	8/3/2020 13:31	mg / cm ^2	trim	metal	D	intact	white	negative	<LOD	0.03
17	8/3/2020 13:33	mg / cm ^2	wall	concrete	D	intact	white	negative	<LOD	0.03
18	8/3/2020 13:34	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
19	8/3/2020 13:37	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
20	8/3/2020 13:38	mg / cm ^2	door	metal	D	intact	brown	negative	<LOD	0.03
21	8/3/2020 13:38	mg / cm ^2	wall	concrete	A	intact	white	negative	<LOD	0.03
22	8/3/2020 13:39	mg / cm ^2	trim	metal	A	intact	white	negative	<LOD	0.03
23	8/3/2020 13:44	mg / cm ^2	door	metal	C	intact	brown	negative	<LOD	0.03
24	8/3/2020 13:45	mg / cm ^2	door	wood	C	intact	brown	negative	<LOD	0.03
25	8/3/2020 13:46	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
26	8/3/2020 13:46	mg / cm ^2	wall	drywall	C	intact	white	negative	<LOD	0.03
27	8/3/2020 13:47	mg / cm ^2	wall	drywall	B	intact	white	negative	<LOD	0.03
28	8/3/2020 13:47	mg / cm ^2	window	metal	B	intact	brown	negative	<LOD	0.03
29	8/3/2020 13:48	mg / cm ^2	wall	drywall	A	intact	white	positive	4.4	2.8
30	8/3/2020 13:49	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
31	8/3/2020 13:49	mg / cm ^2	wall	drywall	A	intact	white	positive	10.8	6.2
32	8/3/2020 13:50	mg / cm ^2	wall	drywall	A	intact	white	positive	11.2	6.6
33	8/3/2020 13:50	mg / cm ^2	wall	drywall	A	intact	white	positive	11.6	6.5
34	8/3/2020 13:50	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
35	8/3/2020 13:51	mg / cm ^2	wall	drywall	A	intact	white	positive	<LOD	14.7
36	8/3/2020 13:52	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
37	8/3/2020 13:53	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
38	8/3/2020 13:54	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
39	8/3/2020 13:55	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
40	8/3/2020 13:59	mg / cm ^2	wall	drywall	A	intact	black	negative	<LOD	0.03
41	8/3/2020 13:59	mg / cm ^2	wall	drywall	D	intact	black	negative	<LOD	0.03
42	8/3/2020 14:00	mg / cm ^2	wall	drywall	B	intact	black	negative	<LOD	0.03

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
43	8/3/2020 14:06	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
44	8/3/2020 14:07	mg / cm ^2	wall	drywall	A	intact	white	negative	<LOD	0.03
45	8/3/2020 14:08	mg / cm ^2	wall	drywall	D	intact	white	negative	<LOD	0.03
46	8/3/2020 14:08	mg / cm ^2	door	metal	D	intact	blue	negative	<LOD	0.03
47	8/3/2020 14:09	mg / cm ^2	door	metal	D	intact	blue	negative	<LOD	0.03
48	8/3/2020 14:11	mg / cm ^2	column	metal	B	intact	white	negative	<LOD	0.03
49	8/3/2020 14:12	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
50	8/3/2020 14:12	mg / cm ^2	door	metal	A	intact	white	negative	<LOD	0.03
51	8/3/2020 14:13	mg / cm ^2	door	metal	A	intact	white	negative	<LOD	0.03
52	8/3/2020 14:15	mg / cm ^2	wall	concrete	A	intact	yellow	negative	<LOD	0.03
53	8/3/2020 14:16	mg / cm ^2	wall	concrete	D	intact	yellow	negative	<LOD	0.03
54	8/3/2020 14:16	mg / cm ^2	wall	drywall	C	intact	yellow	negative	<LOD	0.03
55	8/3/2020 14:18	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
56	8/3/2020 14:19	mg / cm ^2	door	metal	D	intact	white	negative	<LOD	0.03
57	8/3/2020 14:21	mg / cm ^2	door	metal	D	intact	brown	negative	<LOD	0.03
58	8/3/2020 14:22	mg / cm ^2	wall	concrete	C	intact	white	negative	<LOD	0.03
59	8/3/2020 14:23	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
60	8/3/2020 14:24	mg / cm ^2	cabinet	wood	B	intact	white	negative	<LOD	0.03
61	8/3/2020 14:25	mg / cm ^2	wall	concrete	B	intact	brown	negative	<LOD	0.03
62	8/3/2020 14:26	mg / cm ^2	wall	concrete	B	intact	brown	negative	<LOD	0.05
63	8/3/2020 14:28	mg / cm ^2	floor	concrete	A	intact	brown	negative	<LOD	0.03
64	8/3/2020 14:28	mg / cm ^2	floor	concrete	A	intact	brown	negative	<LOD	0.03
65	8/3/2020 14:31	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
66	8/3/2020 14:31	mg / cm ^2	wall	concrete	D	intact	white	negative	<LOD	0.03
67	8/3/2020 14:32	mg / cm ^2	wall	drywall	D	intact	white	negative	<LOD	0.03
68	8/3/2020 14:33	mg / cm ^2	wall	drywall	D	intact	white	negative	<LOD	0.03
69	8/3/2020 14:34	mg / cm ^2	wall	drywall	C	intact	green	negative	<LOD	0.03
70	8/3/2020 14:34	mg / cm ^2	door	metal	B	intact	white	negative	<LOD	0.03
71	8/3/2020 14:35	mg / cm ^2	door	metal	B	intact	white	negative	<LOD	0.03
72	8/3/2020 14:35	mg / cm ^2	wall	drywall	B	intact	red	negative	<LOD	0.03
73	8/3/2020 14:41	mg / cm ^2	door	metal	B	intact	brown	negative	<LOD	0.03
74	8/3/2020 14:41	mg / cm ^2	wall	wood	D	intact	white	negative	<LOD	0.03
75	8/3/2020 14:42	mg / cm ^2	wall	wood	D	intact	white	negative	<LOD	0.03
76	8/3/2020 14:42	mg / cm ^2	wall	wood	A	intact	brown	negative	<LOD	0.03
77	8/3/2020 14:43	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
78	8/3/2020 14:47	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
79	8/3/2020 14:47	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
80	8/3/2020 14:48	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.07
81	8/3/2020 14:48	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.12
82	8/3/2020 14:49	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.45
83	8/3/2020 14:50	mg / cm ^2	wall	concrete	B	intact	white	negative	<LOD	0.03
84	8/3/2020 14:52	mg / cm ^2	wall	concrete	A	intact	yellow	negative	<LOD	0.03

No.	Time	Units	Component	Substrate	Side	Condition	Color	Results	PbC	Error
85	8/3/2020 14:52	mg / cm ^2	column	metal	A	intact	yellow	negative	<LOD	0.03
86	8/3/2020 14:54	mg / cm ^2	floor	ceramic	A	intact	brown	negative	<LOD	0.03
87	8/3/2020 15:09	mg / cm ^2	door	metal	A	intact	blue	negative	<LOD	0.03
88	8/3/2020 15:10	mg / cm ^2	door	metal	A	intact	blue	negative	<LOD	0.03
89	8/3/2020 15:18	mg / cm ^2						positive	1	0.1
90	8/3/2020 15:18	mg / cm ^2						positive	1	0.1
91	8/3/2020 15:22	mg / cm ^2						positive	0.9	0.1

< LOD = below level of detection

APPENDIX C

PERSONNEL QUALIFICATIONS



NICKOLAUS DASANTOS

Environmental Business Unit Manager

PROFESSIONAL EXPERIENCE

Mr. DaSantos is a Manager with NOVA's Environmental Group in Kennesaw, Georgia. Mr. DaSantos has experience as an environmental consultant performing all aspects of Phase I and Phase II Environmental Site Assessments (ESAs), Risk Hazard Assessments (RHAs), National Environmental Policy Act (NEPA) Assessments, Georgia Environmental Policy Act (GEPA) Assessments, Prospective Purchaser Corrective Action Plans (PPCAPs), Hazardous Site Response Act (HSRA) Notifications, Brownfield Applications, Compliance Status Reports (CSRs), Oversight for the assessment, excavation, removal and remediation of Underground Storage Tanks (USTs), and the installation of soil borings/groundwater monitoring wells, surface and groundwater sampling, soil sampling, multi-incremental soil sampling, stockpile soil sampling, Toxicity Characteristic Leaching Procedure (TCLP) sampling, Mold Assessments, Radon Assessments, Radon Mitigation Design, Radon Mitigation Installation Oversight, biocell construction/remediation, and Vapor Intrusion Assessments, Vapor Intrusion Mitigation (VIMS) Design, Vapor Intrusion Mitigation System Installation Oversight.

Mr. DaSantos is experienced in performing pre-renovation/pre-demolition asbestos inspections, lead based paint inspections, mold inspections, as well as large asbestos, lead based paint, and hazardous materials abatement oversight projects.

Mr. DaSantos is also experienced in assessment and remediation of hazardous waste sites impacted by chlorinated solvents, petroleum hydrocarbons, and other chemical substances released into the environment. Mr. DaSantos has knowledge of state and federal environmental programs and government regulations, including RCRA, HSRA, CERCLA, UST/LUST, AHERA, ASHARA, and OSHA.

Education:

BS, Natural Science, with emphasis in Geology, University of Alaska at Anchorage 2011
BA, Philosophy, University of Georgia 2000
Certificate of Environmental Ethics, University of Georgia, 2000

REPRESENTATIVE PROJECT EXPERIENCE

Municipal/Government

Asbestos Inspection, Alaska Department of Natural Resources, Healy, AK
Asbestos Inspection, Federal Courthouse Building, Rome, GA
Phase I ESA, GEPA Assessment, Cherokee County Sheriff's Facility, Canton, GA
Lead Inspection, Canton, GA
Quarterly Groundwater Monitoring, Well Closure, Municipal Fueling Facility, Canton, GA
Monitoring Well Closure, Canton, GA
Mold Inspections and Mold Air Sampling, Multiple Fire Stations and Police Stations, Cherokee County, GA

Asbestos Inspection, Lead Based Paint Inspection, Asbestos Abatement Oversight, Lead Based Paint Abatement Oversight, UST Closure, City of Newnan, GA
Phase I ESA, Phase II ESA, multiple Fire and Police Department facilities, Clayton County, GA
GEPA and Phase I ESA, Police Department Training Facility, Canton, GA
Asbestos Inspection, Asbestos Abatement Oversight, Hazardous Building Material Inventory, Centers for Disease Control (CDC), Atlanta, GA
Phase I ESA, Former Public Library, Homer, AK



Certifications / Registrations: REPRESENTATIVE PROJECT EXPERIENCE

U.S. EPA Lead Inspector
Certification No. 1892
Certified Niton XRF Operator
AHERA (Asbestos) Building
Inspector/Asbestos in
Buildings: Management Plan
(Management Planner)
Certificate No. 18010
Asbestos Abatement Designer
Certificate No. 4396
Control of Respirable
Crystalline Silica Dust
40 hour HAZWOPER Training

Education

Asbestos Inspection, Lead Based
Paint Inspection, Hazardous Materials
Survey, Phase I ESA, Agnes Scott
College, Atlanta, GA

Asbestos Inspections, Asbestos
Management Planning, Lead
Inspections, RHAs, Mold Inspections,
City Schools of Decatur, Decatur, GA

Asbestos Inspection, Asbestos
Abatement Design Specifications,
Asbestos Abatement Oversight, Lead
Based Paint Inspection,
Polychlorinated Biphenyl Inspection,
Hazardous Materials Remediation
Oversight, Kennesaw State University,
Kennesaw, GA

Asbestos Inspection, Asbestos
Abatement Design Specifications,
Lead Based Paint Inspection,
Hazardous Materials Survey, Phase I
ESA, Spelman College, Atlanta, GA

Asbestos and Lead Based Paint
Inspection, Fairmount Elementary
School, Fairmount, GA

Lead Inspection, North Springs High
School, Sandy Springs, GA

Georgia Environmental Policy Act
(GEPA) Assessment and Phase I ESA,
Technical College System of Georgia,
Edison, GA

Risk Hazard Assessment, Kipp Strive
Academy, Atlanta, GA

UST Remediation Specifications,
Georgia State University, Atlanta,
GA

Asbestos Inspection, Lead Based
Paint Inspection, West Georgia
College, Carrollton, GA

AHERA 3-Year Re-Inspection, St.
Mary's Catholic School, Rome, GA

Phase I and II ESA, Soil Sampling,
UST Removal, Georgia
Environmental Policy Act
Assessment, Chattahoochee
Technical College, Woodstock, GA

Asbestos and Radon Survey,
Abatement Specifications, Lovett
School, Atlanta, GA

Electromagnetic Frequency (EMF)
Study and High Voltage Electric
Transmission Line Risk Assessment
Study, DeKalb County Schools,
DeKalb, GA

Phase I ESA and RHA, Atlanta Public
Schools, Atlanta, GA

Phase I ESAs, RHAs, DeKalb County
Schools System, DeKalb County, GA

Soil Sampling, Georgia Gwinnett
College, Lawrenceville, GA

Soil Sampling, Kipp Ways Academy,
Atlanta, GA

AHERA 3-Year Re-Inspection, St.
Catherine of Sienna Catholic
School, Kennesaw, GA

AHERA 3-Year Re-Inspection, St.
Joseph Catholic School,
Marietta, GA

AHERA 3-Year Re-Inspection, Our
Lady of Mercy Catholic High School,
Fayetteville, GA

Asbestos Abatement Oversight,
St. Pius X Catholic High School,
Atlanta, GA

AHERA 3-Year Re-Inspection,
St. Peter Claver Catholic School,
Decatur, GA

GEPA and Phase I ESA, Gordon
County Career Academy,
Calhoun, GA

REPRESENTATIVE PROJECT EXPERIENCE

Residential

Prospective Purchaser Corrective Action Plans, Brownfield Applications, Compliance Status Reports, HSRA Notifications, Water Usage Surveys, Multiple Sites, Atlanta, GA

Radon Mitigation Design
Multiple Locations,
Atlanta, GA

Radon Mitigation Design
33 Level Residential Tower,
Atlanta, GA

Vapor Intrusion Surveys (Pre- and Post-Construction), Multiple Sites, Atlanta, GA

Radon Assessment
Apartment Complex
Hampton, GA

Radon Surveys, Multiple Locations, AK, GA, NC and SC

Oversight for the assessment, excavation, removal and remediation of Underground Storage Tanks (USTs) multiple sites throughout GA, NC, and AK

Decommissioning of Heating Oil USTs, Anchorage, AK

Phase I ESA, Hazardous Building Material Inventory, TCLP Sampling, Anchorage, AK

UST Contaminated Soil Excavation, Talkeetna, AK

Asbestos and Lead Based Paint Inspection, Phase I ESA, Farm, Trapper Creek, AK

Groundwater Monitoring, Trapper Creek, AK

Asbestos Inspection, Slocomb, AL

Multiple Phase I ESAs, Greenspace, Athens, GA

Asbestos Inspection, Lead Based Paint Inspection, Phase I ESA, Multiple Sites, AL, AK, GA, NC, SC, FL, TN

Retail

Phase I ESA, Strip Mall, Eagle River, AK

Decommissioning of USTs & Lead Soil Screening, Service Station, Anchorage, AK

Ponce City Market
Radon Assessment,
Atlanta, GA

Radon Mitigation Design
23 Level Tower, Mixed-Use/Retail,
Atlanta, GA

Office

Asbestos and Lead Based Paint Inspection, Big Brothers and Big Sisters Atlanta Office Building, Atlanta, GA

Asbestos and Lead Based Paint Inspection, Hazardous Building Materials Inventory, 22-Level High Rise Office Building, Peachtree Road, Atlanta, GA

Lead Based Paint Inspection, 52-Level High Rise Office Building, Atlanta, GA

Radon Mitigation Design
Multiple Locations,
Atlanta, GA

REPRESENTATIVE PROJECT EXPERIENCE

Recreational

Asbestos Operations and Maintenance Plan, City Hall East/Ponce City Market, Atlanta, GA

Soils Assessment, National College Football Hall of Fame, Atlanta, GA

Lead Based Paint Sampling, Delta Heritage Museum, Atlanta, GA

Aviation

Groundwater Monitoring, Airstrip, Nikiski, AK

Manufacturing/Industrial

Asbestos and Polychlorinated Biphenyl (PCB) Inspection, GE Manufacturing Facility, Murfreesboro, TN

Asbestos, Lead Based Paint, Hazardous Materials Survey, Siemens Facility, Atlanta, GA

Asbestos Inspection, Beverage Can Manufacturing Facility, Forest Park, GA

Asbestos Dust Wipe Sampling, Brake Manufacturing Facility, Cartersville, GA

Asbestos and Lead Based Paint Inspection, Train Depot, Blue Ridge, GA

Asbestos and Lead Based Paint Inspection, Phase I ESA, Phase II ESA, Groundwater and Soil Sampling, Former Cotton Mill, Jackson, GA

Multi-Family/Mixed Use

Asbestos and Lead Based Paint Inspections, Phase I ESAs, Multiple Office/Retail Facilities, Anchorage, AK

Radon Assessment Multiple Office/Retail Facilities, Atlanta, GA

The Environmental Institute

Nickolaus DaSantos

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Asbestos in Buildings: Inspector & Management Planner Refresher

July 21, 2020

Course Date

18010

Certificate Number

July 21, 2020

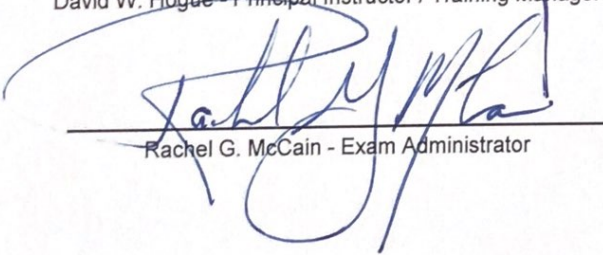
Examination Date

July 20, 2021

Expiration Date



David W. Hogue - Principal Instructor / Training Manager



Rachel G. McCain - Exam Administrator



(Approved by the ABIH Certification Maintenance Committee for 1 CM point - Approval #11-583)

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Nickolaus DaSantos

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Lead Inspector Refresher

December 9, 2019

Course Date

1892

Certificate Number

December 9, 2019

Examination Date

December 8, 2021

Georgia Expiration Date

December 8, 2023

EPA Expiration Date



Bonnie B. Maurras - Principal Instructor

David W. Hogue - Training Manager

(Approved by the ABIH Certification Maintenance Committee for 1 CM point - Approval #11-584)

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(State of Georgia Accredited - Certification No. 20-0799-006SR - September 21, 1999)



CURTIS MOSES

Staff Professional

PROFESSIONAL EXPERIENCE

Mr. Moses is a Staff Professional with NOVA's Environmental Group. Mr. Moses has experience as an environmental professional providing various aspects of environmental consultation. His experience includes performing pre-renovation/pre-demolition asbestos inspections, lead based paint inspections, lead risk assessments, indoor air quality studies, microbial assessments, Phase I Site Assessments as well as large-scale asbestos and lead abatement oversight. He has worked in this industry since 2006.

Certifications / Registrations:

NIOSH 582, Certificate No. 2260
AHERA (Asbestos) Building Inspector, Certificate No.17425
South Carolina (Asbestos) No. BI-00805
North Carolina (Asbestos) No. 12831
Alabama (Asbestos) No. AIN0516610139
West Virginia (Asbestos) No. AI008032
U.S. EPA Lead Risk Assessor Certificate No. 1914
GA EPD Lead Risk Assessor Certificate No. 70RA00715
U.S. EPA Lead Inspector, Certificate No. 1876
GA EPD Lead Inspector, Certificate No. 60INS00215
Control of Respirable Crystalline Silica Dust Training
40 Hr. HAZWOPER, Certificate No. 2749407
8 Hr. HAZWOPER Certificate No. 1608045175860
Radiation Safety and Operation, Certificate No. RS0038000001TmqA
Geo-Seal Certified Inspector 472018

REPRESENTATIVE PROJECT EXPERIENCE

Education

Asbestos Inspection, Agnes Scott College Dormitory, Atlanta, GA
AHERA 3-Year Re-Inspection, Asbestos Inspection, Abatement Oversight, Pace Academy, Atlanta, GA
AHERA 3-Year Re-Inspection, City of Atlanta Schools
AHERA 3-Year Re-Inspection, Abatement Oversight, Clearance Monitoring, Darlington School, Rome, GA
TEM Clearance Testing, Abatement Oversight, Marist School, Atlanta, GA
Asbestos Inspection, Gwinnett County Schools, Norcross, GA
Asbestos Inspection and Clearance Monitoring, University of Georgia, Athens, GA
Asbestos Inspection, Abatement Oversight, Newnan Hospital Redevelopment, Newnan, GA
AHERA 3-Year Re-Inspection Christ the King Catholic School, Atlanta, GA
AHERA 3-Year Re-Inspection Immaculate Heart of Mary Catholic School, Atlanta, GA

AHERA 3-Year Re-Inspection St. Jude the Apostle Catholic School, Atlanta, GA
AHERA 3-Year Re-Inspection St. John the Evangelist Catholic School, Hapeville, GA
AHERA 3-Year Re-Inspection, Operations and Maintenance Assessment, and Hazardous Building Materials Survey, Marist School, Atlanta, GA
TEM Clearance Testing, Asbestos Sampling, University of North Carolina at Charlotte
Asbestos Inspection International Community School
Asbestos Inspection, Whitfield County Schools, Dalton, GA
Asbestos Abatement Oversight and Clearance Sampling, Whitfield County Schools, Dalton, GA
Lead Inspection, Agnes Scott College – Rebekah Hall, Atlanta, GA
Asbestos Inspection, Lead Inspection, CY Grant Gymnasium, North Georgia Technical College, Clarksville, GA
Microbial Assessment, Maxwell Road, Alpharetta, GA
Asbestos Inspection, Our Lady of the Assumption Catholic School, Atlanta, GA



Asbestos Inspection, Jordan Hall,
Decatur, GA

REPRESENTATIVE PROJECT EXPERIENCE

Education con't

AHERA 3-Year Re-Inspection
Clairemont Elementary School,
Decatur, GA

AHERA 3-Year Re-Inspection College
Heights Elementary School,
Decatur, GA

AHERA 3-Year Re-Inspection
Decatur High School, Decatur, GA

AHERA 3-Year Re-Inspection
Glenwood Elementary School,
Decatur, GA

AHERA 3-Year Re-Inspection
Oakhurst Elementary School,
Decatur, GA

AHERA 3-Year Re-Inspection
Renfroe Middle School, Decatur, GA

AHERA 3-Year Re-Inspection
Winnona Park Elementary School,
Decatur, GA

Abatement Oversight, Kennesaw
State University, Library
Renovations. Kennesaw, GA

Lead Based Paint, Asbestos
Inspection, and Hazardous Building
Materials Inventory, 222 Piedmont,
Atlanta, GA

Abatement Oversight, Renfroe
Middle School Renovations,
Decatur, GA

Residential

Lead Inspection, Asbestos
Abatement Oversight, Clearance
Monitoring, Briarcliff Summit,
Atlanta, GA

Multiple Unit Asbestos Inspection,
Renovations, Fort Gordon, GA

Multiple Unit Asbestos Inspection,
Renovations, Fort Stewart, GA

Asbestos Abatement Oversight, On
Site Fiber Counting, Shaw Air Force
Base, Shaw, SC

3455 Old Alabama Road, John's
Creek, GA

Lead Inspection, Dormitory, Georgia
Institute of Technology, Atlanta, GA

Microbial Assessment, Abatement
Oversight, Golden Living Center,
Dunwoody, GA

Microbial Assessment, Marietta, GA

Asbestos Abatement Oversight,
Golden Living Center, Rome, GA

Asbestos Abatement Oversight,
Golden Living Center, Decatur, GA

Asbestos Inspection, Old Alabama
Road, Johns Creek, GA

Radon Testing, Hampton Court
Apartments, Hampton, GA

Microbial Assessment, Avery Road
Apartments, Covington, GA

Remediation Oversight, Atlanta, GA

Lead Based Paint and Asbestos
Inspection, 312 South Candler
Street, Atlanta, GA

Abatement Monitoring and
Oversight, City Hall East, Atlanta, GA

REPRESENTATIVE PROJECT EXPERIENCE

Office/Industrial/Commercial

Asbestos Inspection, Asbestos and Lead Abatement Oversight, Clearance Monitoring, City Hall East/Ponce City Market, Atlanta, GA

Asbestos Inspection, General Motors Plant, Doraville, GA

Asbestos Inspection, Asbestos Abatement Oversight, Clearance Monitoring, Town of Trion Hospital, Trion, GA

Asbestos Abatement Oversight, Belmont Hills, Marietta, GA

Asbestos Inspection, Abatement Oversight and On Site Fiber Counting, Lockheed Martin, Marietta, GA

Asbestos Abatement Oversight, Clearance Monitoring, World of Coke Offices, Atlanta, GA

Asbestos Inspection, Former Georgia Department of Transportation, Atlanta, GA

Microbial Assessment, Clearance Testing, Retail Facilities, Roswell, GA

Lead Inspection, Asbestos Inspection, Abatement Oversight Barracks, Fort Benning, GA

Lead Inspection, Asbestos Inspection, 2 Capitol Square, Atlanta, GA

Asbestos inspection, Newnan Hospital, Newnan, GA

Asbestos Inspection, Lead Inspection, Noel Place Office Tower, Nashville, TN

Asbestos Abatement Oversight, Clearance Monitoring, Circle 75 Office Park Renovations, Atlanta, GA

Asbestos Inspection, Weems Road Warehouse Redevelopment, GA

Lead Inspection, Asbestos inspection, Former Days Inn, Northside Drive, Atlanta, GA

Asbestos Inspection, 60 11th Street, Atlanta, GA

Microbial Assessment, Flat Shoals Road, Union City, GA

Asbestos Inspection, Lead based Paint Inspection, and Abatement Oversight, Newnan Hospital Redevelopment, Newnan, GA

Phase I ESA, 87 Jackson Street, Newnan, GA

Soil sampling and remediation oversight, Goodwill Development, Decatur, GA

Lead Inspection, Asbestos Inspection, Forsyth County Courthouse Renovations

Lead Inspection, Georgia Pacific Center Mechanical Rooms & Stairwells, Atlanta, GA

Microbial Assessment, Ashville, Buncombe, NC

Asbestos Inspections, 11575 Maxwell Road, Roswell, GA

Asbestos Inspection, Floor and Décor, Buford, GA

Phase I ESA, 246 North Arcadia, Decatur, GA

Phase I ESA, 4900 Ivey Road, Acworth, GA

Asbestos Inspection, Dialysis Center, Savannah, GA

Asbestos Inspection, Dialysis Center, Brunswick, GA

Asbestos Inspection, The Candler Building, Atlanta, GA

Lead Based Paint and Asbestos Inspection, The Variety Playhouse, Atlanta, GA



Curtis Moses
Staff Professional

Asbestos Suite Inspections,
Stonecrest Mall, Lithonia, GA

Asbestos Inspection, Lead Based
Paint Inspection, Hazardous
Building Materials Inventory, and
Abatement Specifications, Metro
State Prison Facility, Atlanta, GA

Asbestos Inspection, Bells Ferry
Station #1, Acworth, GA

Abatement Oversight and Clearance
Air Sampling Savannah Street Boys
and Girls Club Renovation and
Demolition, Newnan, GA

Abatement Oversight and Clearance
Air Sampling Savannah Street Boys
and Girls Club Renovation and
Demolition, Newnan, GA

Phase II Site Assessment
Huff Road Tract
Atlanta, GA

Phase II Site Assessment
20 Linden
Atlanta, GA

The Environmental Institute

Curtis Moses

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Asbestos in Buildings: Inspector Refresher

June 4, 2020

Course Date

17943

Certificate Number

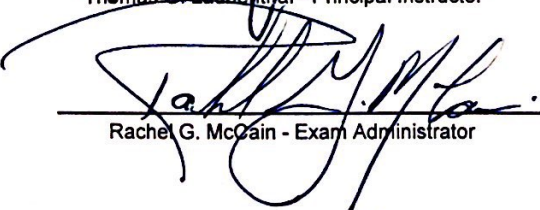
June 4, 2020

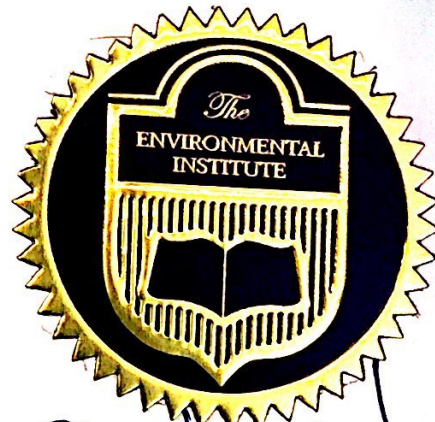
Examination Date


June 3, 2021

Expiration Date


Thomas G. Laubenthal - Principal Instructor


Rachel G. McCain - Exam Administrator




David W. Hogue - Training Manager

(Approved by the ABIH Certification Maintenance Committee for 1/2 CM point - Approval #11-577)

(Florida Provider Registration Number FL49-0001342 - Course #FL49-0002805)

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The Environmental Institute

Curtis Moses

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Nova - 3900 Kennesaw 75 Parkway, Suite 100 - Kennesaw, Georgia 30144

Has completed coursework and satisfactorily passed the hands-on skills assessment and an examination that meets training criteria in accordance with requirements for Lead-Based Paint Activities in Target Housing and Child-Occupied Facilities as regulated by Georgia DNR/EPD Chapter 391-3-24 and U. S. EPA TSCA 40 CFR Part 745 for the refresher course titled

Lead Inspector Refresher

February 7, 2019

Course Date

1876

Certificate Number

February 7, 2019

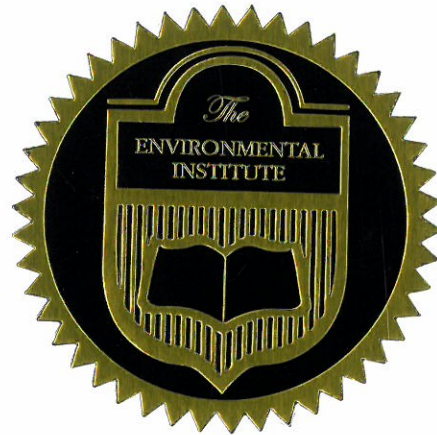
Examination Date

February 6, 2021

Georgia Expiration Date

February 6, 2022

EPA Expiration Date



A handwritten signature in blue ink, appearing to read "Bonnie B. Maurras".

Bonnie B. Maurras - Principal Instructor

A handwritten signature in blue ink, appearing to read "David W. Hogue".

David W. Hogue - Training Manager

(Approved by the ABIH Certification Maintenance Committee for 1 CM point - Approval #11-584)
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(State of Georgia Accredited - Certification No. 20-0799-006SR - September 21, 1999)

APPENDIX D

QUALIFICATIONS OF CONCLUSIONS

QUALIFICATIONS OF CONCLUSIONS

The findings and opinions presented are relative to the dates of our site work and should not be relied on to represent conditions at substantially later dates or locations not investigated.

The opinions included herein are based on information obtained during the study and our experience. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinions, if necessary.

Assessments may include interviews, a review of documents prepared by others or other secondary information sources. NOVA has not verified the provided information and has no responsibility for the accuracy or completeness of the information.

Although this assessment has attempted to identify the potential for environmental impacts to the subject property, potential sources of contamination may have escaped detection due to: (1) the limited scope of this assessment, (2) the inaccuracy of public records, (3) the presence of undetected or unreported environmental incidents, (4) inaccessible areas and/or (5) deliberate concealment of detrimental information. It was not the purpose of this study to determine the actual presence, degree or extent of contamination at the site, except as specifically described in the previous sections of this report. This would require additional exploratory work, including supplemental sampling and laboratory analysis.

This report is intended for the sole use of **Sizemore Group**. The scope of work performed during this study was developed for purposes specifically intended by **Sizemore Group** and may not satisfy other user requirements. Use of this report or the findings and conclusions by others will be at the sole risk of the user.

Our professional services have been performed, our findings obtained, our conclusions derived and our recommendations prepared in accordance with generally accepted engineering practices and principles. This statement is in lieu of all other statements or warranties, either expressed or implied.

LIMITED FLUID AND SOIL SAMPLING



Gwinnett Technical College Building 100 Renovation

Lawrenceville, Georgia

PREPARED FOR:

Sizemore Group
342 Marietta Street, NW
Unit 3
Atlanta, Georgia 30313

NOVA Project Number: 3020091

September 18, 2020



PROFESSIONAL | PRACTICAL | PROVEN



September 18, 2020

SIZEMORE GROUP

342 Marietta Street, NW
Unit 3
Atlanta, Georgia 30313

Attention: Ms. Tulia Scott, AIA, NCARB, NOMA, LEED AP BD+C
Director of Architecture

Subject: Limited Fluid and Soil Sampling
GWINNETT TECHNICAL COLLEGE BUILDING 100 RENOVATION
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091

Dear Ms. Scott:

NOVA Engineering and Environmental, LLC (NOVA) has completed the authorized Limited Fluid and Soil Sampling for the acid dilution basin associated with the Gwinnett Technical College Building 100 Renovation located at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia. The work was performed in general accordance with NOVA Proposal Number 002-30207757, dated August 24, 2020.

The Limited Fluid and Soil Sampling work was performed in general accordance with ASTM International (ASTM) *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process, Designation: E1903-11* unless otherwise stated herein. The attached report presents our understanding of the project information, a description of the environmental consulting services provided by NOVA, and our findings and conclusions.

We appreciate your selection of NOVA and the opportunity to be of service on this project. If you have any questions, or if we may be of further assistance, please do not hesitate to contact us.

Sincerely,
NOVA Engineering and Environmental, LLC

Nathan Parker
Project Geologist

Keith Rice, P.G.
Senior Professional Geologist
Environmental Services

Copies Submitted: Addressee (electronic)

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APPENDICES

- Appendix A – Figures
- Appendix B – Laboratory Data
- Appendix C – Qualifications of Conclusions

1.0 INTRODUCTION

NOVA Engineering and Environmental, LLC (NOVA) was retained by Sizemore Group (Client) to complete Limited Fluid and Soil Sampling for the acid dilution basin associated with the Gwinnett Technical College (GTC) Building 100 Renovation located at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia (Subject Property). Figures are contained in Appendix A.

1.1 SITE AND PROJECT INFORMATION

Our understanding of the Subject Property scope of work is based on documentation provided in an e-mail from Ms. Tulia Scott of Sizemore Group (Client) on July 6, 2020, July 31, 2020 and August 17, 2020. The Subject Property is identified as Building 100 and is located on the Gwinnett Technical College (GTC) campus at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia (Subject Property). According to Client-provided documents, a 30-gallon subsurface acid dilution basin associated with a photography laboratory is located in room 203A. This basin is reportedly 30.5" deep and 17.25" wide. A Site Location Map is provided as Figure 1 in Appendix A.

NOVA's Limited Soil Sampling was conducted to characterize the soil surrounding the subsurface acid dilution tank.

1.2 LIMITATIONS

NOVA has performed the Limited Soil Sampling in general accordance with ASTM 1903-11, which is a limited inquiry into a property's environmental status and is not sufficient to discover every potential source of environmental liability or environmental impact, if any, of the property to be evaluated. No ESA can wholly eliminate uncertainty regarding the potential for *Recognized Environmental Conditions* (RECs) in connection with a property. Performance of this Limited Soil Sampling is intended to reduce, but not eliminate, uncertainty regarding the potential for RECs in connection with a property, and this practice recognizes reasonable limits of time and cost.

The level of inquiry is variable. Not every property will warrant the same level of assessment. Consistent with good commercial or customary practices, the appropriate level of ESA will be guided by the type of property subject to assessment, the expertise and risk tolerance of Sizemore Group (Client or User), and the information developed in the course of the inquiry.

NOVA's assessment represents our professional opinion, only. Therefore, NOVA cannot, under any circumstances, make a statement of warranty or guarantee, expressed or implied, that RECs, environmental impairment, or environmental impacts are limited to those that are discovered while we are performing the Limited Soil Sampling.

1.3 USER RELIANCE

NOVA's Limited Fluid and Soil Sampling report, along with the findings and conclusions contained in the report, either in completed form, summary form, or by extraction, is prepared, and intended, for the sole use of the Client and therefore may not contain sufficient information for other purposes or parties. The Client is the only intended beneficiary of this report. The contents of NOVA's report will continue to be the property of NOVA. NOVA's report may not be disclosed to, used by, or relied upon by, any person or entity other than the Client without the express written consent of NOVA.

Authorization for disclosure to a third party or authorization for third-party reliance on a final report of any report will be considered by NOVA upon the written request of the Client. NOVA reserves the right to deny authorization to allow disclosure or reliance of NOVA's report to third parties.

2.0 LIMITED FLUID AND SOIL SAMPLING

Sizemore Group requested that NOVA conduct Limited Fluid and Soil Sampling to characterize the fluid inside and the soil surrounding the subsurface acid dilution basin. Our investigation procedures, findings, conclusions, and recommendations are presented in the following sections. A Boring and Sampling Location Map is provided as Figure 2 in Appendix A.

2.1 FLUID SAMPLING

On September 4, 2020, NOVA collect one (1) fluid sample from the subsurface acid dilution basin to characterize its contents. The collected sample was submitted to Analytical Environmental Services (AES) of Atlanta, Georgia, an appropriately accredited laboratory for the following analyses:

- Resource Conservation and Recovery Act (RCRA) 8 Metals by United States Environmental Protection Agency (US EPA) Solid Waste (SW)-846 Method 6010D and 7470A,
- pH by US EPA SW-846 Method 4500H+B.

A total of one (1) fluid sample of the basin contents was collected. The sample was kept on ice for same-day transport to AES under proper chain-of-custody procedures.

2.2 SOIL BORING INSTALLATION AND SOIL SAMPLING

NOVA advanced three (3) soil borings (N-1 through N-3) to a depth of approximately three (3) feet below ground surface (bgs), using a manual hand auger through soils adjacent the subsurface acid dilution basin and within an approximately three (3) foot by three (3) foot surface vault.

Soil samples were collected at approximately three (3) feet bgs from each of the three (3) borings using a 3.25-inch sampling stainless steel hand auger with sampling bucket.

The three (3) soil samples collected were submitted to AES of Atlanta, Georgia, an appropriately accredited laboratory for the following analyses:

- RCRA 8 Metals by US EPA SW-846 Method 6010D and 7473,
- pH by US EPA SW-846 Method 9045D.

Soil samples were kept on ice for same-day transport to an AES under proper chain-of-custody procedures. The excess soil cuttings were placed in a 5-gallon bucket and returned to each boring following sampling activities. NOVA accessed the bare soil adjacent to the subsurface acid dilution tank within the surface vault and did not require concrete coring and subsequent restoration.

2.3 QUALITY CONTROL AND QUALITY ASSURANCE METHODS

Field procedures and protocols used during the Limited Soil Sampling were performed in general accordance with those prescribed ASTM International (ASTM) Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process, Designation: E1903-19, USEPA Region IV Science and Ecosystem Support Division (SESD) guideline document SESDPROC-300-R3 dated August 21, 2014 for soil sampling, and guideline document SESDPROC-301-R4 dated April 26, 2017 for groundwater sampling.

Samples were labeled with a distinct sample identification number, the sampler's initials and the date of collection. Each sample container was properly sealed, labeled, and placed in an ice chest (with ice) for same-day transport to an accredited laboratory (AES) which used USEPA SW-846 protocols. A properly completed chain-of-custody form was initiated in the field and accompanied the samples when submitted to the laboratory for analyses. Copies of the chain-of custody form(s) are shown in Appendix B.

3.0 RESULTS

3.1 SOIL LABORATORY RESULTS

The complete laboratory analytical reports for soil sample N-1-3' N-2-3' and N-3-3' are included in Appendix B.

3.1.1 Soil Metals Constituents

The following Metals constituents were detected in soil at concentrations that exceeded the laboratory reporting limits in soil samples N-1-3' N-2-3' and N-3-3':

	GA EPD HSRA NC*	N-1-3' (2.5'-3')	N-2-3' (2.5'-3')	N-3-3' (2.5'-3')
Barium	500	57.4	59.5	62.8
Chromium	1,200	12.2	9.65	8.99
Lead	400	15.2	17.1	15.8

Results in milligrams per kilograms (mg/kg)

() feet below grade

* Georgia Environmental Protection Division (GA EPD) Hazardous Site Response Act (HSRA) Notification Concentration (NC)

The metals detected are below GA EPD HSRA program Notification Concentrations (NCs). Additionally, the identified concentrations of Barium, Chromium, and Lead are consistent with background concentrations that naturally occur in Piedmont geology soils.

3.1.2 Soil pH

The following pH levels were detected in soil samples N-1-3' N-2-3' and N-3-3':

	N-1-3' (2.5'-3')	N-2-3' (2.5'-3)	N-2-3' (2.5-3')
pH	4.92	4.81	4.79

() feet below grade

3.2 FLUID LABORATORY RESULTS

The complete laboratory analytical reports for the fluid sample PIT-1 is included in Appendix B.

3.2.1 Fluid Metals Constituents

The following Metals constituents were detected in soil at concentrations that exceeded the laboratory reporting limits in soil samples N-1-3' N-2-3' and N-3-3':

	PIT-1
Barium	58.1
Silver	39.2

Results in micrograms per liter ($\mu\text{g/L}$)

3.2.2 Fluid pH

The following pH levels were detected in fluid sample PIT-1:

	PIT-1
pH	7.36

4.0 CONCLUSIONS

NOVA performed Limited Fluid and Soil Sampling at the Gwinnett Technical College (GTC) Building 100 Renovation site located at 5150 Sugarloaf Parkway in Lawrenceville, Gwinnett County, Georgia. The study was performed in a manner generally consistent with the requirements of the ASTM 1903-11 and generally accepted industry standards.

Soil Results

The metals Barium, Chromium and Lead were detected at concentrations below GA EPD HSRA program Notification Concentrations (NCs). Additionally, the identified concentrations of Barium, Chromium, and Lead are consistent with background concentrations that naturally occur in Piedmont geology soils.

The pH of the soil samples analyzed ranged from 4.79 to 4.92.

Fluid Results

Barium and Silver were detected in the collected fluid sample at 58.1 micrograms per liter ($\mu\text{g/L}$) and 39.2 $\mu\text{g/L}$, respectively.

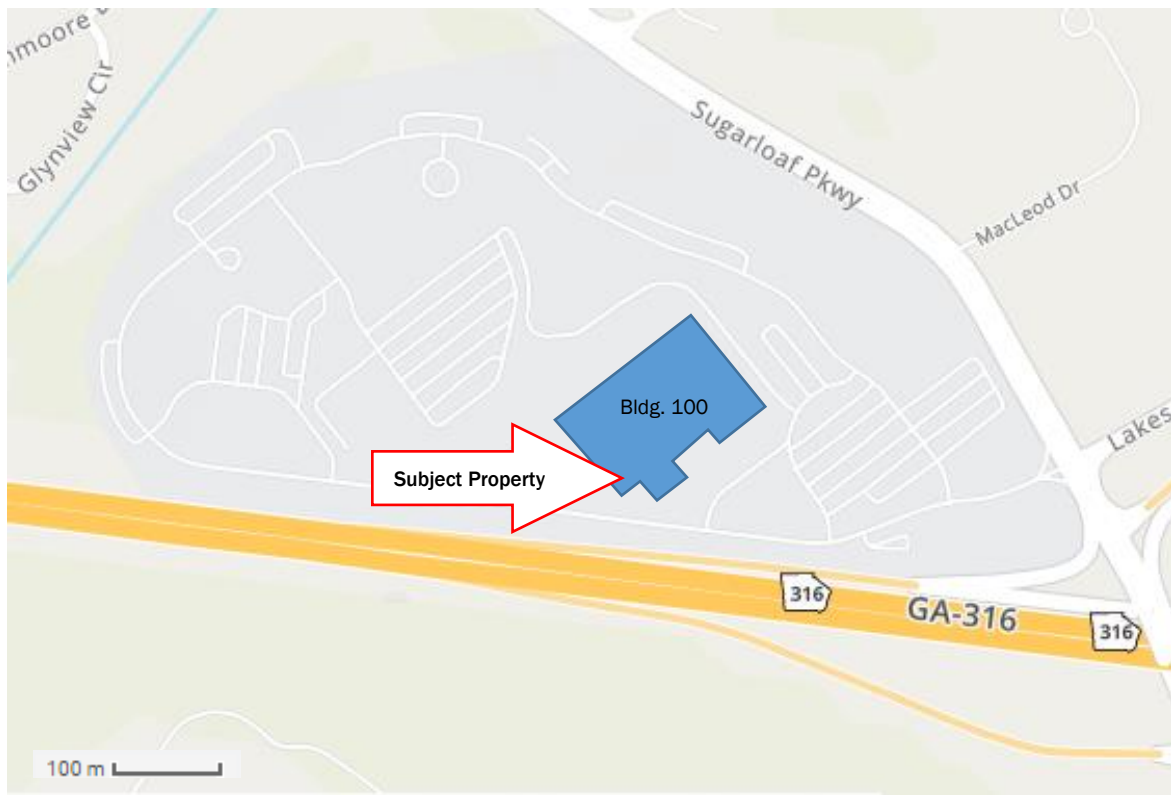
The pH of the fluid sample analyzed was 7.36.

The fluids from the sub-surface acid dilution basin and soil from around the subsurface acid dilution basin requiring removal should be disposed in accordance with applicable rules and regulations.

Based on the findings, opinions, and conclusions of this Limited Fluid and Soil Sampling, NOVA recommends no further assessment with regards to the environmental condition of the Subject Property at this time.

APPENDIX A

FIGURES



**FIGURE 1
SITE LOCATION MAP**

SOURCE: mapquest.com
DATE: Accessed 07/29/2020
SCALE: As Shown



SIZEMORE GROUP
Gwinnett Technical College
Building 100 Renovation
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091

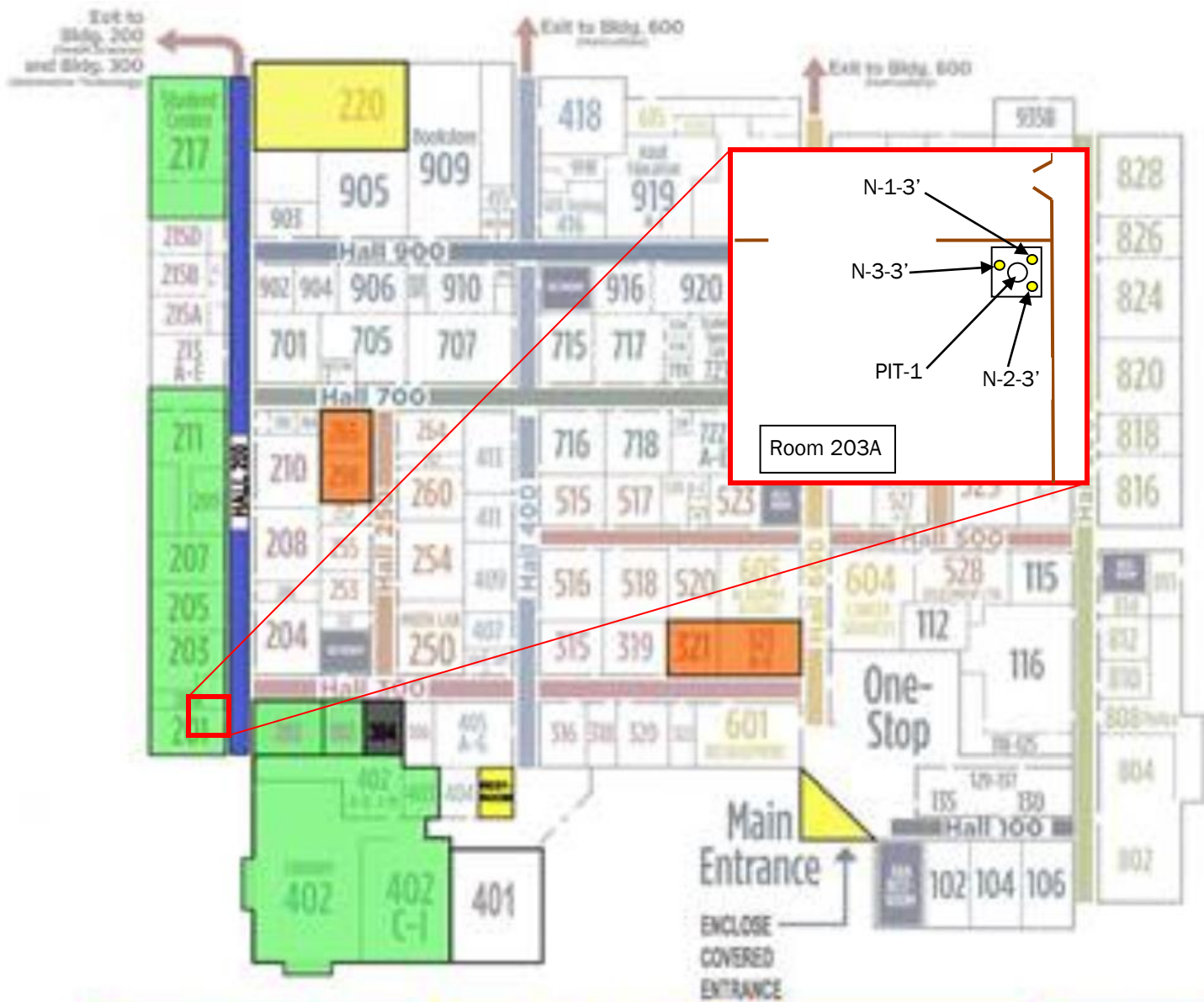


FIGURE 2
BORING & SAMPLING LOCATION MAP

SOURCE: Gwinnett Technical College Building Map
SCALE: Not to Scale



SIZEMORE GROUP
Gwinnett Technical College
Building 100 Renovation
Lawrenceville, Gwinnett County, Georgia
NOVA Project Number 3020091

APPENDIX B

LABORATORY DATA



ANALYTICAL ENVIRONMENTAL SERVICES, INC.

September 10, 2020

Nick DaSantos
Nova Engineering & Environmental, LLC
3900 Kennesaw 75 Pkwy
Kennesaw GA 30144

RE: GTC Building 100

Dear Nick DaSantos:

Order No: 2009642

Analytical Environmental Services, Inc. received 3 samples on 9/4/2020 3:00:00 PM for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.

AES's accreditations are as follows:

-NELAP/State of Florida Laboratory ID E87582 for analysis of Non-Potable Water, Solid & Chemical Materials, Air & Emissions Volatile Organics, and Drinking Water Microbiology & Metals, effective 07/01/20-06/30/21.

State of Georgia, Department of Natural Resources ID #800 for analysis of Drinking Water Metals, effective through 06/30/21 and Total Coliforms/ E. coli, effective 04/20/20-04/24/23.

-AIHA-LAP, LLC Laboratory ID: 100671 for Industrial Hygiene samples (Metals and PCM Asbestos), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) Direct Examination, effective until 11/01/21.

These results relate only to the items tested as received. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Sincerely,

Chris Pafford
Project Manager

Client: Nova Engineering & Environmental, LLC
Project: GTC Building 100
Lab ID: 2009642

Case Narrative

Sample Receiving Nonconformance:

Sample(s) for pH analysis by Method SW9045D were received and analyzed outside Method specified holding time of "immediate or 15 minutes".

Client: Nova Engineering & Environmental, LLC	Client Sample ID: N-1-3'
Project Name: GTC Building 100	Collection Date: 9/4/2020 9:20:00 AM
Lab ID: 2009642-001	Matrix: Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
Total Mercury by SW7473				(SW7473)				
Mercury	BRL	0.125		mg/Kg-dry	302430	1	09/08/2020 16:28	SK
Laboratory Hydrogen Ion (pH) SW9045D				(SW9045D)				
pH	4.92	0.01	H	pH Units	302505	1	09/09/2020 13:41	CB
METALS, TOTAL SW6010D				(SW3050B)				
Arsenic	BRL	2.21		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
Barium	57.4	4.42		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
Cadmium	BRL	2.21		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
Chromium	12.2	2.21		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
Lead	15.2	4.42		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
Selenium	BRL	3.09		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
Silver	BRL	2.21		mg/Kg-dry	302380	1	09/09/2020 12:10	AJ
PERCENT MOISTURE D2216								
Percent Moisture	19.9	0		wt%	R434015	1	09/07/2020 00:00	JW

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value

- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- F Analyzed in the lab which is a deviation from the method
- < Less than Result value
- J Estimated value detected below Reporting Limit

Client: Nova Engineering & Environmental, LLC	Client Sample ID: N-2-3'
Project Name: GTC Building 100	Collection Date: 9/4/2020 10:10:00 AM
Lab ID: 2009642-002	Matrix: Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
Total Mercury by SW7473		(SW7473)						
Mercury	BRL	0.122		mg/Kg-dry	302430	1	09/08/2020 16:36	SK
Laboratory Hydrogen Ion (pH) SW9045D		(SW9045D)						
pH	4.81	0.01	H	pH Units	302505	1	09/09/2020 13:46	CB
METALS, TOTAL SW6010D		(SW3050B)						
Arsenic	BRL	2.62		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
Barium	59.5	5.24		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
Cadmium	BRL	2.62		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
Chromium	9.65	2.62		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
Lead	17.1	5.24		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
Selenium	BRL	3.67		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
Silver	BRL	2.62		mg/Kg-dry	302380	1	09/09/2020 12:12	AJ
PERCENT MOISTURE D2216								
Percent Moisture	18.3	0		wt%	R434015	1	09/07/2020 00:00	JW

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value

- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- F Analyzed in the lab which is a deviation from the method
- < Less than Result value
- J Estimated value detected below Reporting Limit

Client: Nova Engineering & Environmental, LLC	Client Sample ID: N-3-3'
Project Name: GTC Building 100	Collection Date: 9/4/2020 11:00:00 AM
Lab ID: 2009642-003	Matrix: Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
Total Mercury by SW7473				(SW7473)				
Mercury	BRL	0.121		mg/Kg-dry	302430	1	09/08/2020 16:44	SK
Laboratory Hydrogen Ion (pH) SW9045D				(SW9045D)				
pH	4.79	0.01	H	pH Units	302505	1	09/09/2020 13:49	CB
METALS, TOTAL SW6010D				(SW3050B)				
Arsenic	BRL	2.19		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
Barium	62.8	4.38		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
Cadmium	BRL	2.19		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
Chromium	8.99	2.19		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
Lead	15.8	4.38		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
Selenium	BRL	3.06		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
Silver	BRL	2.19		mg/Kg-dry	302380	1	09/09/2020 12:14	AJ
PERCENT MOISTURE D2216								
Percent Moisture	17.5	0		wt%	R434015	1	09/07/2020 00:00	JW

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value

- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- F Analyzed in the lab which is a deviation from the method
- < Less than Result value
- J Estimated value detected below Reporting Limit

SUMMARY OF ANALYTES DETECTED

Analyses	Result	Qual	Reporting Limit	Units	BatchID	Dilution Factor
Client Sample ID: N-1-3'						
Collection Date: 9/4/2020 9:20:00 AM						
Lab ID: 2009642-001						
Matrix: Soil						
Laboratory Hydrogen Ion (pH) SW9045D (SW9045D)						
pH	4.92	H	0.01	pH Units	302505	1
METALS, TOTAL SW6010D (SW3050B)						
Barium	57.4		4.42	mg/Kg-dry	302380	1
Chromium	12.2		2.21	mg/Kg-dry	302380	1
Lead	15.2		4.42	mg/Kg-dry	302380	1
PERCENT MOISTURE D2216						
Percent Moisture	19.9		0	wt%	R434015	1
Client Sample ID: N-2-3'						
Collection Date: 9/4/2020 10:10:00 AM						
Lab ID: 2009642-002						
Matrix: Soil						
Laboratory Hydrogen Ion (pH) SW9045D (SW9045D)						
pH	4.81	H	0.01	pH Units	302505	1
METALS, TOTAL SW6010D (SW3050B)						
Barium	59.5		5.24	mg/Kg-dry	302380	1
Chromium	9.65		2.62	mg/Kg-dry	302380	1
Lead	17.1		5.24	mg/Kg-dry	302380	1
PERCENT MOISTURE D2216						
Percent Moisture	18.3		0	wt%	R434015	1
Client Sample ID: N-3-3'						
Collection Date: 9/4/2020 11:00:00 AM						
Lab ID: 2009642-003						
Matrix: Soil						
Laboratory Hydrogen Ion (pH) SW9045D (SW9045D)						
pH	4.79	H	0.01	pH Units	302505	1
METALS, TOTAL SW6010D (SW3050B)						
Barium	62.8		4.38	mg/Kg-dry	302380	1
Chromium	8.99		2.19	mg/Kg-dry	302380	1
Lead	15.8		4.38	mg/Kg-dry	302380	1
PERCENT MOISTURE D2216						
Percent Moisture	17.5		0	wt%	R434015	1

Qualifiers:

* Value exceeds maximum contaminant level	E Estimated (value above quantitation range)
BRL Below reporting limit	S Spike Recovery outside limits due to matrix
H Holding times for preparation or analysis exceeded	Narr See case narrative
N Analyte not NELAC certified	F Analyzed in the lab which is a deviation from the method
B Analyte detected in the associated method blank	< Less than Result value
> Greater than Result value	J Estimated value detected below Reporting Limit

SAMPLE/COOLER RECEIPT CHECKLIST

1. Client Name: Nova Engineering & Environmental, LLC

AES Work Order Number: 2009642

2. Carrier: FedEx UPS USPS Client Courier Other _____

	Yes	No	N/A	Details	Comments
3. Shipping container/cooler received in good condition?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	damaged <input type="checkbox"/> leaking <input type="checkbox"/> other <input type="checkbox"/>	
4. Custody seals present on shipping container?	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>		
5. Custody seals intact on shipping container?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
6. Temperature blanks present?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
7. Cooler temperature(s) within limits of 0-6°C? [See item 13 and 14 for temperature recordings.]	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Cooling initiated for recently collected samples / ice present <input type="checkbox"/>	
8. Chain of Custody (COC) present?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
9. Chain of Custody signed, dated, and timed when relinquished and received?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
10. Sampler name and/or signature on COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
11. Were all samples received within holding time?	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>		
12. TAT marked on the COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	If no TAT indicated, proceeded with standard TAT per Terms & Conditions. <input type="checkbox"/>	

13. Cooler 1 Temperature 4.3 °C Cooler 2 Temperature _____ °C Cooler 3 Temperature _____ °C Cooler 4 Temperature _____ °C
 14. Cooler 5 Temperature _____ °C Cooler 6 Temperature _____ °C Cooler 7 Temperature _____ °C Cooler 8 Temperature _____ °C

15. Comments: _____

I certify that I have completed sections 1-15 (dated initials). NZ 9-4-2020

	Yes	No	N/A	Details	Comments
16. Were sample containers intact upon receipt?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
17. Custody seals present on sample containers?	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>		
18. Custody seals intact on sample containers?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
19. Do sample container labels match the COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	incomplete info <input type="checkbox"/> illegible <input type="checkbox"/> no label <input type="checkbox"/> other <input type="checkbox"/>	
20. Are analyses requested indicated on the COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
21. Were all of the samples listed on the COC received?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	samples received but not listed on COC <input type="checkbox"/> samples listed on COC not received <input type="checkbox"/>	
22. Was the sample collection date/time noted?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
23. Did we receive sufficient sample volume for indicated analyses?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
24. Were samples received in appropriate containers?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
25. Were VOA samples received without headspace (< 1/4" bubble)?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
26. Were trip blanks submitted?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	listed on COC <input type="checkbox"/> not listed on COC <input type="checkbox"/>	

27. Comments: _____

This section only applies to samples where pH can be checked at Sample Receipt. I certify that I have completed sections 16-27 (dated initials). LM 9/4/20

	Yes	No	N/A	Details	Comments
28. Have containers needing chemical preservation been checked? *	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
29. Containers meet preservation guidelines?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
30. Was pH adjusted at Sample Receipt?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		

* Note: Certain analyses require chemical preservation but must be checked in the laboratory and not upon Sample Receipt such as Coliforms, VOCs and Oil & Grease/TPH. This also excludes metals by EPA 200.7, 200.8 and 245.1 which will be verified between 16 and 24 hours after preservation. I certify that I have completed sections 28-30 (dated initials). LM 9/4/20

Client: Nova Engineering & Environmental, LLC
 Project Name: GTC Building 100
 Lab Order: 2009642

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
2009642-001A	N-1-3'	9/4/2020 9:20:00AM	Soil	TOTAL METALS BY ICP		9/8/2020 12:45:00PM	09/09/2020
2009642-001A	N-1-3'	9/4/2020 9:20:00AM	Soil	Mercury by SW7473		9/8/2020 1:14:37PM	09/08/2020
2009642-001A	N-1-3'	9/4/2020 9:20:00AM	Soil	Laboratory Hydrogen Ion (pH)		9/9/2020 12:00:00PM	09/09/2020
2009642-001A	N-1-3'	9/4/2020 9:20:00AM	Soil	PERCENT MOISTURE			09/07/2020
2009642-002A	N-2-3'	9/4/2020 10:10:00AM	Soil	TOTAL METALS BY ICP		9/8/2020 12:45:00PM	09/09/2020
2009642-002A	N-2-3'	9/4/2020 10:10:00AM	Soil	Mercury by SW7473		9/8/2020 1:14:37PM	09/08/2020
2009642-002A	N-2-3'	9/4/2020 10:10:00AM	Soil	Laboratory Hydrogen Ion (pH)		9/9/2020 12:00:00PM	09/09/2020
2009642-002A	N-2-3'	9/4/2020 10:10:00AM	Soil	PERCENT MOISTURE			09/07/2020
2009642-003A	N-3-3'	9/4/2020 11:00:00AM	Soil	TOTAL METALS BY ICP		9/8/2020 12:45:00PM	09/09/2020
2009642-003A	N-3-3'	9/4/2020 11:00:00AM	Soil	Mercury by SW7473		9/8/2020 1:14:37PM	09/08/2020
2009642-003A	N-3-3'	9/4/2020 11:00:00AM	Soil	Laboratory Hydrogen Ion (pH)		9/9/2020 12:00:00PM	09/09/2020
2009642-003A	N-3-3'	9/4/2020 11:00:00AM	Soil	PERCENT MOISTURE			09/07/2020

Client: Nova Engineering & Environmental, LLC
Project Name: GTC Building 100
Workorder: 2009642

ANALYTICAL QC SUMMARY REPORT

BatchID: 302380

Sample ID: MB-302380	Client ID:	Units: mg/Kg	Prep Date: 09/08/2020	Run No: 434148							
SampleType: MBLK	TestCode: METALS, TOTAL SW6010D	BatchID: 302380	Analysis Date: 09/09/2020	Seq No: 9861482							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	BRL	2.50									
Barium	BRL	5.00									
Cadmium	BRL	2.50									
Chromium	BRL	2.50									
Lead	BRL	5.00									
Selenium	BRL	3.50									
Silver	BRL	2.50									

Sample ID: LCS-302380	Client ID:	Units: mg/Kg	Prep Date: 09/08/2020	Run No: 434148							
SampleType: LCS	TestCode: METALS, TOTAL SW6010D	BatchID: 302380	Analysis Date: 09/09/2020	Seq No: 9861484							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	47.89	2.50	50.00		95.8	80	120				
Barium	50.19	5.00	50.00		100	80	120				
Cadmium	48.73	2.50	50.00		97.5	80	120				
Chromium	50.05	2.50	50.00		100	80	120				
Lead	49.49	5.00	50.00		99.0	80	120				
Selenium	43.18	3.50	50.00		86.4	80	120				
Silver	4.992	2.50	5.000		99.8	80	120				

Sample ID: 2009507-002AMS	Client ID:	Units: mg/Kg-dry	Prep Date: 09/08/2020	Run No: 434148							
SampleType: MS	TestCode: METALS, TOTAL SW6010D	BatchID: 302380	Analysis Date: 09/09/2020	Seq No: 9861487							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	36.64	2.07	41.44	2.113	83.3	70	130				
Barium	126.3	4.14	41.44	94.62	76.4	70	130				
Cadmium	38.67	2.07	41.44	0.1871	92.9	70	130				
Chromium	82.59	2.07	41.44	47.94	83.6	70	130				

Qualifiers: > Greater than Result value < Less than Result value B Analyte detected in the associated method blank
 BRL Below reporting limit E Estimated (value above quantitation range) H Holding times for preparation or analysis exceeded
 J Estimated value detected below Reporting Limit N Analyte not NELAC certified R RPD outside limits due to matrix
 Rpt Lim Reporting Limit S Spike Recovery outside limits due to matrix

Client: Nova Engineering & Environmental, LLC
Project Name: GTC Building 100
Workorder: 2009642

ANALYTICAL QC SUMMARY REPORT

BatchID: 302380

Sample ID: 2009507-002AMS	Client ID:	Units: mg/Kg-dry	Prep Date: 09/08/2020	Run No: 434148							
SampleType: MS	TestCode: METALS, TOTAL SW6010D	BatchID: 302380	Analysis Date: 09/09/2020	Seq No: 9861487							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Lead	544.7	4.14	41.44	497.3	114	70	130				
Selenium	33.44	2.90	41.44		80.7	70	130				
Silver	4.038	2.07	4.144	0.07656	95.6	70	130				

Sample ID: 2009507-002AMSD	Client ID:	Units: mg/Kg-dry	Prep Date: 09/08/2020	Run No: 434148							
SampleType: MSD	TestCode: METALS, TOTAL SW6010D	BatchID: 302380	Analysis Date: 09/09/2020	Seq No: 9861489							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	36.53	2.07	41.34	2.113	83.3	70	130	36.64	0.301	20	
Barium	122.0	4.13	41.34	94.62	66.3	70	130	126.3	3.40	20	S
Cadmium	38.23	2.07	41.34	0.1871	92.0	70	130	38.67	1.15	20	
Chromium	84.17	2.07	41.34	47.94	87.6	70	130	82.59	1.89	20	
Lead	153.5	4.13	41.34	497.3	-832	70	130	544.7	112	20	SR
Selenium	33.44	2.89	41.34		80.9	70	130	33.44	0.012	20	
Silver	3.983	2.07	4.134	0.07656	94.5	70	130	4.038	1.37	20	

Qualifiers:	>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
	BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
	J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
	Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: Nova Engineering & Environmental, LLC
Project Name: GTC Building 100
Workorder: 2009642

ANALYTICAL QC SUMMARY REPORT

BatchID: 302430

Sample ID: MB-302430	Client ID:	Units: mg/Kg	Prep Date: 09/08/2020	Run No: 434093							
SampleType: MBLK	TestCode: Total Mercury by SW7473	BatchID: 302430	Analysis Date: 09/08/2020	Seq No: 9859733							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury BRL 0.100

Sample ID: LCS-302430	Client ID:	Units: mg/Kg	Prep Date: 09/08/2020	Run No: 434093							
SampleType: LCS	TestCode: Total Mercury by SW7473	BatchID: 302430	Analysis Date: 09/08/2020	Seq No: 9859734							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury 0.9176 0.100 1.000 91.8 80 120

Sample ID: 2009026-001EMS	Client ID:	Units: mg/Kg-dry	Prep Date: 09/08/2020	Run No: 434093							
SampleType: MS	TestCode: Total Mercury by SW7473	BatchID: 302430	Analysis Date: 09/08/2020	Seq No: 9859736							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury 2.874 0.288 2.456 117 80 120

Sample ID: 2009026-001EMSD	Client ID:	Units: mg/Kg-dry	Prep Date: 09/08/2020	Run No: 434093							
SampleType: MSD	TestCode: Total Mercury by SW7473	BatchID: 302430	Analysis Date: 09/08/2020	Seq No: 9859737							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury 2.821 0.288 2.469 114 80 120 2.874 1.84 20

Qualifiers:	> Greater than Result value	< Less than Result value	B Analyte detected in the associated method blank
	BRL Below reporting limit	E Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded
	J Estimated value detected below Reporting Limit	N Analyte not NELAC certified	R RPD outside limits due to matrix
	Rpt Lim Reporting Limit	S Spike Recovery outside limits due to matrix	

Client: Nova Engineering & Environmental, LLC
Project Name: GTC Building 100
Workorder: 2009642

ANALYTICAL QC SUMMARY REPORT

BatchID: 302505

Sample ID: LCS-302505	Client ID:	Units: pH Units	Prep Date: 09/09/2020	Run No: 434173							
SampleType: LCS	TestCode: Laboratory Hydrogen Ion (pH) SW9045D	BatchID: 302505	Analysis Date: 09/09/2020	Seq No: 9862577							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

pH 6.980 0.01 7.000 99.7 90 110

Sample ID: 2009642-001ADUP	Client ID: N-1-3'	Units: pH Units	Prep Date: 09/09/2020	Run No: 434173							
SampleType: DUP	TestCode: Laboratory Hydrogen Ion (pH) SW9045D	BatchID: 302505	Analysis Date: 09/09/2020	Seq No: 9862663							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

pH 4.900 0.01 4.920 0.407 10 H

Qualifiers:	> Greater than Result value	< Less than Result value	B Analyte detected in the associated method blank
BRL	Below reporting limit	E Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N Analyte not NELAC certified	R RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S Spike Recovery outside limits due to matrix	

End of Report



ANALYTICAL ENVIRONMENTAL SERVICES, INC.

September 10, 2020

Nick DaSantos
Nova Engineering & Environmental, LLC

3900 Kennesaw 75 Pkwy
Kennesaw GA 30144

RE: GTC Bldg 100

Dear Nick DaSantos:

Order No: 2009643

Analytical Environmental Services, Inc. received 1 samples on 9/4/2020 3:00:00 PM
for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated
Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the
analyses contained herein will be noted and submitted in the form of a project Case Narrative.

AES's accreditations are as follows:

-NELAP/State of Florida Laboratory ID E87582 for analysis of Non-Potable Water, Solid & Chemical
Materials, Air & Emissions Volatile Organics, and Drinking Water Microbiology & Metals, effective
07/01/20-06/30/21.

State of Georgia, Department of Natural Resources ID #800 for analysis of Drinking Water Metals, effective
through 06/30/21 and Total Coliforms/ E. coli, effective 04/20/20-04/24/23.

-AIHA-LAP, LLC Laboratory ID: 100671 for Industrial Hygiene samples (Metals and PCM Asbestos),
Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) Direct
Examination, effective until 11/01/21.

These results relate only to the items tested as received. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Sincerely,

Chris Pafford
Project Manager

CHAIN OF CUSTODY

COMPANY: <u>North Eng & Env.</u>		ADDRESS: <u>3900 Kennesaw 75 Pkwy #100</u> <u>Kennesaw, GA 30144</u>				ANALYSIS REQUESTED						Visit our website www.aesatlanta.com for downloadable COCs and to log in to your AESAccess account.	Number of Containers		
PHONE: <u>470-515-8835</u>		EMAIL: <u>nparker@usanova.com</u>				RCPA-8-Meds PH									
SAMPLED BY: <u>N. Parker</u>		SIGNATURE:													
#	SAMPLE ID	SAMPLED:		GRAB	COMPOSITE	MATRIX (see codes)	PRESERVATION (see codes)						REMARKS		
		DATE	TIME				H	I	I	I	I	I			
1	<u>Pit-1</u>	<u>9/4/20</u>	<u>1120</u>	<u>X</u>		<u>WW</u>	<u>X</u>	<u>X</u>							<u>2</u>
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
RELINQUISHED BY: <u></u>		DATE/TIME: <u>9/4/20 15:00</u>		RECEIVED BY: <u></u>		DATE/TIME: <u>9-4-20 15:00 pm</u>		PROJECT INFORMATION						RECEIPT	
1. <u></u>				1. <u></u>				PROJECT NAME: <u>GTC Bldg 100</u>						Total # of Containers <u>2</u>	
2.				2.				PROJECT #: <u>3020 091</u>						Turnaround Time (TAT) Request	
3.				3.				SITE ADDRESS: <u>Sugarloaf Pkwy, Lawrenceville GA</u>						<input checked="" type="checkbox"/> Standard	
SPECIAL INSTRUCTIONS/COMMENTS:				SHIPMENT METHOD				SEND REPORT TO: <u>N. Parker + K. Rice</u>						<input type="checkbox"/> 2 Business Day Rush	
				OUT: / / VIA:				INVOICE TO (IF DIFFERENT FROM ABOVE):						<input type="checkbox"/> Next Business Day Rush	
				IN: <u>Client</u> / / VIA:				QUOTE #: _____ PO#: _____						<input type="checkbox"/> Same-Day Rush (auth req.)	
				other: _____										<input type="checkbox"/> Other _____	
														REGULATORY PROGRAM (if any):	
														DATA PACKAGE: I <input type="radio"/> II <input type="radio"/> III <input type="radio"/> IV <input type="radio"/>	

Submission of samples to the laboratory constitutes acceptance of AES's Terms & Conditions. Client assumes sole responsibility for damage or loss of samples before we accept them. Samples received after 3PM or on Saturday are considered as received the following business day. If no TAT is marked on COC, AES will proceed with standard TAT. Samples are disposed of 30 days after completion of report unless other arrangements are made.

Matrix Codes: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water ST = Stormwater WW = Waste Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify)

4.30.20_COC

Preservative Codes: H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

Client: Nova Engineering & Environmental, LLC
Project: GTC Bldg 100
Lab ID: 2009643

Case Narrative

Sample Receiving Nonconformance:

Samples for pH analysis by Method SM4500 H+ B was received and analyzed outside Method specified holding time of "immediate or 15 minutes".

Client: Nova Engineering & Environmental, LLC	Client Sample ID: PIT-1
Project Name: GTC Bldg 100	Collection Date: 9/4/2020 11:20:00 AM
Lab ID: 2009643-001	Matrix: Waste Water

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
Mercury, Total SW7470A					(SW7470A)			
Mercury	BRL	0.200		ug/L	302539	1	09/10/2020 15:09	SK
Hydrogen Ion (pH) by SM4500H+B								
pH	7.36	0.0100	H	pH Units	R434016	1	09/08/2020 09:35	CB
METALS, TOTAL SW6010D					(SW3010A)			
Arsenic	BRL	10.0		ug/L	302469	1	09/10/2020 11:07	AJ
Barium	58.1	20.0		ug/L	302469	1	09/10/2020 11:07	AJ
Cadmium	BRL	5.00		ug/L	302469	1	09/10/2020 11:07	AJ
Chromium	BRL	10.0		ug/L	302469	1	09/10/2020 11:07	AJ
Lead	BRL	10.0		ug/L	302469	1	09/10/2020 11:07	AJ
Selenium	BRL	20.0		ug/L	302469	1	09/10/2020 11:07	AJ
Silver	39.2	10.0		ug/L	302469	1	09/10/2020 11:07	AJ

Qualifiers:	* Value exceeds maximum contaminant level	E Estimated (value above quantitation range)
	BRL Below reporting limit	S Spike Recovery outside limits due to matrix
	H Holding times for preparation or analysis exceeded	Narr See case narrative
	N Analyte not NELAC certified	F Analyzed in the lab which is a deviation from the method
	B Analyte detected in the associated method blank	< Less than Result value
	> Greater than Result value	J Estimated value detected below Reporting Limit

SUMMARY OF ANALYTES DETECTED

Analyses	Result	Qual	Reporting Limit	Units	BatchID	Dilution Factor								
<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:20%;">Client Sample ID:</td> <td style="width:30%;">PIT-1</td> <td style="width:20%;">Lab ID:</td> <td style="width:30%;">2009643-001</td> </tr> <tr> <td>Collection Date:</td> <td>9/4/2020 11:20:00 AM</td> <td>Matrix:</td> <td>Waste Water</td> </tr> </table>							Client Sample ID:	PIT-1	Lab ID:	2009643-001	Collection Date:	9/4/2020 11:20:00 AM	Matrix:	Waste Water
Client Sample ID:	PIT-1	Lab ID:	2009643-001											
Collection Date:	9/4/2020 11:20:00 AM	Matrix:	Waste Water											
Hydrogen Ion (pH) by SM4500H+B														
pH	7.36	H	0.0100	pH Units	R434016	1								
METALS, TOTAL SW6010D			(SW3010A)											
Barium	58.1		20.0	ug/L	302469	1								
Silver	39.2		10.0	ug/L	302469	1								

Qualifiers:

* Value exceeds maximum contaminant level	E Estimated (value above quantitation range)
BRL Below reporting limit	S Spike Recovery outside limits due to matrix
H Holding times for preparation or analysis exceeded	Narr See case narrative
N Analyte not NELAC certified	F Analyzed in the lab which is a deviation from the method
B Analyte detected in the associated method blank	< Less than Result value
> Greater than Result value	J Estimated value detected below Reporting Limit

SAMPLE/COOLER RECEIPT CHECKLIST

1. Client Name: **Nova Engineering & Environmental, LLC**

AES Work Order Number: **2009643**

2. Carrier: FedEx UPS USPS Client Courier Other _____

	Yes	No	N/A	Details	Comments
3. Shipping container/cooler received in good condition?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	damaged <input type="checkbox"/> leaking <input type="checkbox"/> other <input type="checkbox"/>	
4. Custody seals present on shipping container?	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>		
5. Custody seals intact on shipping container?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
6. Temperature blanks present?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
7. Cooler temperature(s) within limits of 0-6°C? [See item 13 and 14 for temperature recordings.]	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	Cooling initiated for recently collected samples / ice present <input type="checkbox"/>	
8. Chain of Custody (COC) present?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
9. Chain of Custody signed, dated, and timed when relinquished and received?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
10. Sampler name and/or signature on COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
11. Were all samples received within holding time?	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>		
12. TAT marked on the COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	If no TAT indicated, proceeded with standard TAT per Terms & Conditions. <input type="checkbox"/>	

13. Cooler 1 Temperature 4.3 °C Cooler 2 Temperature _____ °C Cooler 3 Temperature _____ °C Cooler 4 Temperature _____ °C
 14. Cooler 5 Temperature _____ °C Cooler 6 Temperature _____ °C Cooler 7 Temperature _____ °C Cooler 8 Temperature _____ °C

15. Comments: _____

I certify that I have completed sections 1-15 (dated initials). NZ 9-4-2020

	Yes	No	N/A	Details	Comments
16. Were sample containers intact upon receipt?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
17. Custody seals present on sample containers?	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>		
18. Custody seals intact on sample containers?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
19. Do sample container labels match the COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	incomplete info <input type="checkbox"/> illegible <input type="checkbox"/> no label <input type="checkbox"/> other <input type="checkbox"/>	
20. Are analyses requested indicated on the COC?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
21. Were all of the samples listed on the COC received?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	samples received but not listed on COC <input type="checkbox"/> samples listed on COC not received <input type="checkbox"/>	
22. Was the sample collection date/time noted?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
23. Did we receive sufficient sample volume for indicated analyses?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
24. Were samples received in appropriate containers?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
25. Were VOA samples received without headspace (< 1/4" bubble)?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		
26. Were trip blanks submitted?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	listed on COC <input type="checkbox"/> not listed on COC <input type="checkbox"/>	

27. Comments: _____

This section only applies to samples where pH can be checked at Sample Receipt.

I certify that I have completed sections 16-27 (dated initials). LM 9/4/20

	Yes	No	N/A	Details	Comments
28. Have containers needing chemical preservation been checked? *	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
29. Containers meet preservation guidelines?	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>		
30. Was pH adjusted at Sample Receipt?	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		

* Note: Certain analyses require chemical preservation but must be checked in the laboratory and not upon Sample Receipt such as Coliforms, VOCs and Oil & Grease/TPH.

This also excludes metals by EPA 200.7, 200.8 and 245.1 which will be verified between 16 and 24 hours after preservation.

I certify that I have completed sections 28-30 (dated initials). LM 9/4/20

Locked

Client: Nova Engineering & Environmental, LLC
 Project Name: GTC Bldg 100
 Lab Order: 2009643

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
2009643-001A	PIT-1	9/4/2020 11:20:00AM	Waste Water	TOTAL METALS BY ICP		9/9/2020 10:29:00 AM	09/10/2020
2009643-001A	PIT-1	9/4/2020 11:20:00AM	Waste Water	TOTAL MERCURY		9/10/2020 10:20:22 AM	09/10/2020
2009643-001B	PIT-1	9/4/2020 11:20:00AM	Waste Water	Hydrogen Ion (pH) by SM4500 H+ B			09/08/2020

Client: Nova Engineering & Environmental, LLC
 Project Name: GTC Bldg 100
 Workorder: 2009643

ANALYTICAL QC SUMMARY REPORT

BatchID: 302469

Sample ID: MB-302469	Client ID:	Units: ug/L	Prep Date: 09/09/2020	Run No: 434288							
SampleType: MBLK	TestCode: METALS, TOTAL SW6010D	BatchID: 302469	Analysis Date: 09/10/2020	Seq No: 9865579							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	BRL	10.0									
Barium	BRL	20.0									
Cadmium	BRL	5.00									
Chromium	BRL	10.0									
Lead	BRL	10.0									
Selenium	BRL	20.0									
Silver	BRL	10.0									

Sample ID: LCS-302469	Client ID:	Units: ug/L	Prep Date: 09/09/2020	Run No: 434288							
SampleType: LCS	TestCode: METALS, TOTAL SW6010D	BatchID: 302469	Analysis Date: 09/10/2020	Seq No: 9865580							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	1079	50.0	1000		108	80	120				
Barium	1050	20.0	1000		105	80	120				
Cadmium	1063	5.00	1000		106	80	120				
Chromium	1078	10.0	1000		108	80	120				
Lead	1070	10.0	1000		107	80	120				
Selenium	1046	20.0	1000		105	80	120				
Silver	108.1	10.0	100.0		108	80	120				

Sample ID: 2009614-005BMS	Client ID:	Units: ug/L	Prep Date: 09/09/2020	Run No: 434288							
SampleType: MS	TestCode: METALS, TOTAL SW6010D	BatchID: 302469	Analysis Date: 09/10/2020	Seq No: 9865582							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	1064	50.0	1000		106	75	125				
Barium	1067	20.0	1000	33.29	103	75	125				
Cadmium	1047	5.00	1000		105	75	125				
Chromium	1065	10.0	1000		107	75	125				

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: Nova Engineering & Environmental, LLC
 Project Name: GTC Bldg 100
 Workorder: 2009643

ANALYTICAL QC SUMMARY REPORT

BatchID: 302469

Sample ID: 2009614-005BMS	Client ID:	Units: ug/L	Prep Date: 09/09/2020	Run No: 434288							
SampleType: MS	TestCode: METALS, TOTAL SW6010D	BatchID: 302469	Analysis Date: 09/10/2020	Seq No: 9865582							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Lead	1053	10.0	1000		105	75	125				
Selenium	1031	20.0	1000		103	75	125				
Silver	106.6	10.0	100.0		107	75	125				

Sample ID: 2009614-005BMSD	Client ID:	Units: ug/L	Prep Date: 09/09/2020	Run No: 434288							
SampleType: MSD	TestCode: METALS, TOTAL SW6010D	BatchID: 302469	Analysis Date: 09/10/2020	Seq No: 9865583							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Arsenic	1083	50.0	1000		108	75	125	1064	1.74	20	
Barium	1085	20.0	1000	33.29	105	75	125	1067	1.70	20	
Cadmium	1067	5.00	1000		107	75	125	1047	1.93	20	
Chromium	1083	10.0	1000		108	75	125	1065	1.69	20	
Lead	1071	10.0	1000		107	75	125	1053	1.75	20	
Selenium	1056	20.0	1000		106	75	125	1031	2.43	20	
Silver	108.2	10.0	100.0		108	75	125	106.6	1.48	20	

Qualifiers:	>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
	BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
	J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
	Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: Nova Engineering & Environmental, LLC
Project Name: GTC Bldg 100
Workorder: 2009643

ANALYTICAL QC SUMMARY REPORT

BatchID: 302539

Sample ID: MB-302539	Client ID:	Units: ug/L	Prep Date: 09/10/2020	Run No: 434300							
SampleType: MBLK	TestCode: Mercury, Total SW7470A	BatchID: 302539	Analysis Date: 09/10/2020	Seq No: 9865689							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury BRL 0.200

Sample ID: LCS-302539	Client ID:	Units: ug/L	Prep Date: 09/10/2020	Run No: 434300							
SampleType: LCS	TestCode: Mercury, Total SW7470A	BatchID: 302539	Analysis Date: 09/10/2020	Seq No: 9865690							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury 3.714 0.200 4.000 92.8 80 120

Sample ID: 2009643-001AMS	Client ID: PIT-1	Units: ug/L	Prep Date: 09/10/2020	Run No: 434300							
SampleType: MS	TestCode: Mercury, Total SW7470A	BatchID: 302539	Analysis Date: 09/10/2020	Seq No: 9865692							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury 3.440 0.200 4.000 86.0 75 125

Sample ID: 2009643-001AMSD	Client ID: PIT-1	Units: ug/L	Prep Date: 09/10/2020	Run No: 434300							
SampleType: MSD	TestCode: Mercury, Total SW7470A	BatchID: 302539	Analysis Date: 09/10/2020	Seq No: 9865693							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

Mercury 3.654 0.200 4.000 91.4 75 125 3.440 6.03 20

Qualifiers:	> Greater than Result value	< Less than Result value	B Analyte detected in the associated method blank
	BRL Below reporting limit	E Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded
	J Estimated value detected below Reporting Limit	N Analyte not NELAC certified	R RPD outside limits due to matrix
	Rpt Lim Reporting Limit	S Spike Recovery outside limits due to matrix	

Client: Nova Engineering & Environmental, LLC
Project Name: GTC Bldg 100
Workorder: 2009643

ANALYTICAL QC SUMMARY REPORT

BatchID: R434016

Sample ID: 2009288-016CDUP	Client ID:	Units: pH Units	Prep Date:	Run No: 434016							
SampleType: DUP	TestCode: Hydrogen Ion (pH) by SM4500H+B	BatchID: R434016	Analysis Date: 09/08/2020	Seq No: 9859497							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

pH	7.450	0.0100						7.440	0.134	20	H
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Sample ID: 2009448-001BDUP	Client ID:	Units: pH Units	Prep Date:	Run No: 434016							
SampleType: DUP	TestCode: Hydrogen Ion (pH) by SM4500H+B	BatchID: R434016	Analysis Date: 09/08/2020	Seq No: 9859498							
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual

pH	7.060	0.0100						7.060	0	20	H
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Qualifiers:	>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
	BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
	J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
	Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

End of Report

APPENDIX C

QUALIFICATIONS OF CONCLUSIONS

QUALIFICATIONS OF CONCLUSIONS

The findings and opinions presented are relative to the dates of our site work and should not be relied on to represent conditions at substantially later dates or locations not investigated.

The opinions included herein are based on information obtained during the study and our experience. If additional information becomes available which might impact our environmental conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinions, if necessary.

Assessments may include interviews, a review of documents prepared by others or other secondary information sources. NOVA has not verified the provided information and has no responsibility for the accuracy or completeness of the information.

Although this assessment has attempted to identify the potential for environmental impacts to the subject property, potential sources of contamination may have escaped detection due to: (1) the limited scope of this assessment, (2) the inaccuracy of public records, (3) the presence of undetected or unreported environmental incidents, (4) inaccessible areas and/or (5) deliberate concealment of detrimental information. It was not the purpose of this study to determine the actual presence, degree or extent of contamination at the site, except as specifically described in the previous sections of this report. This would require additional exploratory work, including supplemental sampling and laboratory analysis.

This report is intended for the sole use of **Sizemore Group**. The scope of work performed during this study was developed for purposes specifically intended by **Sizemore Group** and may not satisfy other user requirements. Use of this report or the findings and conclusions by others will be at the sole risk of the user.

Our professional services have been performed, our findings obtained, our conclusions derived and our recommendations prepared in accordance with generally accepted engineering practices and principles. This statement is in lieu of all other statements or warranties, either expressed or implied.