

STATE OF ALASKA  
DEPARTMENT OF TRANSPORTATION AND PUBLIC  
FACILITIES  
CENTRAL REGION



PROJECT MANUAL FOR:

**Statewide Library Archives Museum  
Phases 2 and 3**

**Project No. 68816**

**Volume 3 of 3**

**RFP DATE: May 4, 2012**

State of Alaska  
Department of Transportation and Public Facilities  
Central Region  
4111 Aviation Avenue, Anchorage, Alaska 99502

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Phases 2 and 3

Project No.: 68816

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**SECTION 20 00 00**  
**MECHANICAL GENERAL REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Supplemental requirements in addition to Division 1 – General Requirements applicable to all Mechanical Divisions 20, 21, 22, 23 and 25.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
- C. Index of Mechanical Sections:
  - 1. 20 00 00 - Mechanical General Requirements
  - 2. 20 05 29 - Hangers and Supports
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  - 37. 25 55 00 - Variable Speed Drives
  - 38. 25 09 00 - Sequences of Operation

## 1.2 REFERENCES

- A. Codes:
1. Perform work in accordance with the latest legally enacted editions of applicable international and State Codes with locally accepted amendments to include:
    - a. International Building Code (IBC) - 2009.
    - b. International Mechanical Code (IMC) - 2009.
    - c. International Fire Code (IFC) - 2009.
    - d. International Energy Conservation Code (IECC) - 2009.
    - e. Uniform Plumbing Code (UPC) - 2009.
    - f. NFPA 70, National Electric Code (NEC) - 2011.
    - g. Americans with Disabilities Act of 1990 (ADA) as described in "Accessibility Guidelines for Buildings and Facilities."
- B. Standards:
1. Provide materials, equipment, and installation methods which comply with the current standards of the following trade organizations:
    - a. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.
    - b. National Fire Protection Association - NFPA.
    - c. Sheet Metal and Air Conditioning Contractors National Association, Inc. - SMACNA.
    - d. American National Standards Institute - ANSI.
    - e. American Society for Testing and Materials - ASTM.
    - f. American Society of Mechanical Engineers - ASME.
    - g. National Electrical Manufacturers' Association - NEMA.
    - h. American Gas Association - AGA.

## 1.3 DEFINITIONS

- A. "Accessible" means arranged so that an appropriately dressed man 6'-2" tall, weighing 250 pounds, may approach the area in question with the tools and products necessary for the work intended; and may then position himself to properly perform the task to be accomplished, without disassembly or damage to the surrounding installation.
- B. "Authority Having Jurisdiction" is the individual official, board, department, or agency established and authorized by the political subdivision created by law to administer and enforce the provisions of the Code as adopted or amended.
- C. "As Specified" denotes a product, system, or installation that:
1. Includes salient characteristics identified in the Drawings and Specifications.
  2. Meets the requirements of the "Basis of Design".
  3. Is produced by a manufacturer listed as acceptable on the Drawings or in the Specifications.
- D. "Basis of Design" refers to products around which the design was prepared. Some or all of the particular characteristics of Basis of Design products may be critical to the fit or performance of the completed installation. Such characteristics are often subtle. Where substitutions are made to products that are the Basis of Design, the Contractor is alerted that nominally acceptable substitutions may produce undesirable side effects such as products that no longer fit the space due to increased product dimensions. The Contractor is responsible for resolving impacts of substitutions. Approval of a substitution request does not relieve the Contractor of complying with the design intent and applicable Codes.
- E. "Contracting Agency" is the "Department's Representative" as defined in the General Conditions of the Contract.
- F. "Furnish" means to purchase material as shown and specified, and cart the material to an approved location at the site or elsewhere as noted or agreed to be installed by supporting crafts.

- G. "Install" means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.
- H. "Product" is a generic term that includes materials, equipment, fixtures and any physical item used on the project.
- I. "Provide" means furnish products, labor, subcontracts, and appurtenances required and install to a complete and properly operating, finished condition.
- J. Reference to a specific manufacturer's product (even as "Basis of Design") does not necessarily establish acceptability of that product without regard to compliance with other provisions of these specifications.
- K. "Rough-in and Connect" means provide an appropriate system connection such as, water services with stops, continuous wastes with traps, shutoff valves, and piping connections, testing, etc., for proper operation, and to install products furnished. Equipment furnished is received, uncrated, assembled and set in place by supporting crafts unless they make prior arrangements to hire the installer for this work.
- L. "Serviceable" means arranged so that the component or product in question may be properly removed, and replaced without disassembly, destruction or damage to the surrounding installation. "Serviceable" components shall be "accessible".
- M. "Shop Drawings" are dimensioned working construction drawings drawn to scale to show an entire area of work in sufficient detail to demonstrate service and maintenance clearances and complete coordination of all trades.
- N. Streamlining in many instances, the products, reference standards, and other itemized specifications have been listed without verbiage. In these cases, it is implied that the Contractor shall provide the products and perform in accordance with the references listed.
- O. "Substitution" is a product, system or installation that is not by a listed manufacturer or does not conform to all salient characteristics identified in the Contract Documents, but that the Contractor warrants meets specific requirements listed in the Contract Documents.
- P. "System Drawing" is a diagrammatic engineered drawing that shows the interconnection and relationship between products to demonstrate how the products interact to accomplish the function intended. Examples of system drawings include plumbing diagrams, control and instrumentation diagrams, and wiring diagrams. Some drawings, such as dimensioned and complete Fire Protection Drawings may be both System Drawings and Shop Drawings.

#### 1.4 SYSTEM DESCRIPTION

- A. Performance Requirements:
  - 1. Provide labor, products and services required for the complete installation, checkout, and startup of mechanical systems shown and specified. Coordinate related work, including the work of other crafts, to provide each system complete and in proper operating order.
  - 2. Cooperate with others involved in the project; with due regard to their work, to promote rapid completion of the project.
  - 3. Local Conditions: Become thoroughly familiar with the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions, and other local conditions that may affect the progress and quality of the work.
  - 4. In general, the mechanical, electrical and building automation systems are interrelated. Coordinate the interface and operation of systems so that interrelated systems operate in proper synchronization and balance.
  - 5. Provide labor, materials, and equipment as required to facilitate the formal Commissioning process of systems and equipment within this Division in accordance with Section 01 91 00 – Commissioning.

## 1.5 SUBMITTALS

- A. Refer to Division 1 for general submittal, Closeout submittal and product substitution requirements. In addition, prepare Mechanical Divisions 20, 21, 22, 23 and 25 Submittals in accordance with the following.
- B. General:
  - 1. The Department's Representative is obligated to review Submittals and to return them in a timely manner are conditioned upon the prior review and approval of the Submittals by the Contractor as required by the Construction Contract, and conditioned upon the Contractor's submission of the Submittals in accordance with an approved submittal schedule distributed in advance, identifying the dates that various Submittals will be submitted.
  - 2. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Contract Documents.
  - 3. Submittals will not be checked for quantity.
  - 4. Submittals will not be exhaustively checked for dimension or fit, or for proper technical design of manufactured equipment. Provision of a complete and satisfactory working installation is the responsibility of the Contractor.
  - 5. Furnish suppliers with the applicable portions of the Contract Documents and review and verify that the suppliers' Submittals clearly represent products which comply with the Contract Documents.
- C. Product Submittals:
  - 1. General: This section describes in detail the preparation of mechanical product Submittals. Submittals not provided as described shall be rejected without review. This procedure is designed to accelerate and improve the accuracy of the technical review process, as well as, simplify the preparation of the Installation, Operation, and Maintenance Manuals (IO&Ms) during Project Closeout.
  - 2. Submittal Organization:
    - a. Organize product submittal information in the same order as the products are specified to simplify the technical review process. Provide a separate tabbed divider for Mechanical Divisions 20, 21, 22, 23 and 25 specification sections. Provide the typed section number on each tab.
    - b. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable specification section. Provide sub-tabs within each section for each separate product article. Provide the typed product article number on each tab.
    - c. Provide product submittal information for each product specified in 8-1/2" x 11" format. Fold-out 11" x 17" format is also acceptable.
    - d. If a particular specified product is being omitted from the product submittal or will not be used for the project, provide a single sheet within the article tab identifying the product and annotated with a brief reason why the product is not being submitted, for example: "NOT USED," "NO SUBMITTAL REQUIRED," "TO BE SUBMITTED BY (PROVIDE DATE)," etc. This will inform the reviewer that the product was not overlooked.
    - e. Partial Submittals from individual subcontractors may be provided which cover a particular sub-Contractor's scope of work. In this case, arrange partial Submittals by system classification such as: PLUMBING, HEATING, Fire Protection, VENTILATION, BUILDING AUTOMATION SYSTEM, etc. Within each system classification, arrange product Submittals by specification section, as described, such that each specification section can easily be reorganized into a master set of Mechanical Divisions 20, 21, 22, 23 and 25 product Submittals organized by specification section. This will greatly simplify the preparation of O&M manuals as described below.

- f. Bind product submittal information in 3 inch wide, hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes such that the pages in each binder rest naturally on one side of rings.
  - g. Provide a master table of contents at the front of each volume which lists the Mechanical Divisions 20, 21, 22, 23 and 25 specification sections and indicates which sections are located within each volume.
  - h. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
  - i. Provide identical cover and spine inserts for each product submittal volume.
  - j. For multiple volumes, label each volume
  - k. Include the following typed information on the front cover and spine inserts of each volume:
    - 1). The Department's Representative's Name
    - 2). Project Name
    - 3). Contractor's Name
    - 4). Subcontractor name preparing the submittal.
    - 5). Date that the submittal or resubmittal was initiated.
    - 6). "Mechanical Product Submittals" or "Plumbing Product Submittals" etc. as appropriate.
    - 7). "Volume 1 of X, Volume 2 of X," etc.
3. Product Information:
- a. Indicate manufacturer's name and address, and local supplier's name, address, phone number.
  - b. Indicate each product as "Basis of Design", "As Specified" or as "Proposed Substitution."
  - c. Identify Catalog designation and/or model number.
  - d. Neatly annotate each salient characteristic and design option of the product to demonstrate compliance with the Contract Documents to include: Scheduled information, drawing information and specified information). Clearly indicate product deviations from the Contract Documents and mark out non-applicable items on generic "cut-sheets."
  - e. Include manufacturer provided dimensioned equipment drawings with rough-in mechanical and electrical connections as applicable.
  - f. Include operation characteristics, performance curves and rated capacities as applicable.
  - g. Include motor characteristics and wiring diagrams as applicable.
  - h. Provide basic manufacturer's installation instructions.
4. Product Substitutions:
- a. Clearly indicate both in the section table of contents and on the individual product submittal information each proposed substitution, deviation or change from the product as described in the Contract Documents.
  - b. Product submittal approval does not include substitutions, deviations or changes from the requirements of the Contract Documents unless they are clearly identified. The term "No Exceptions Taken" will not apply to substitutions, deviations or changes not clearly identified.
  - c. Provision of a satisfactory working installation of equal quality to the system as described in the Contract Documents shall be the responsibility of the Contractor.
  - d. Correct unapproved deviations from the Contract Documents discovered in the field as directed by the Department's Representative at no additional cost to the Department.
- D. System Drawings:
1. Submit System Drawings for dynamic elements/systems of the project which are performance specified to include but not limited to: Fire Protection Systems, Building Automation Systems and stand-alone packaged equipment.

2. Prepare system drawings on full sized sheets of the same size as the original construction drawings.
  3. Include with each system a Sequence of Operation narrative which describes each mode of system operation in sufficient detail to demonstrate compliance with the Contract Documents to the satisfaction of the Department's Representative.
- E. Shop Drawings:
1. General:
    - a. The Contract Documents are not intended for nor are they suitable for use as shop drawings. Contract Documents shall not be utilized for the actual fabrication or installation of products or equipment.
    - b. Mechanical Divisions 20, 21, 22, 23 and 25 products and systems shall not be installed without shop drawings approved by the Department's Representative.
    - c. Rework, changes or additional engineering support required as a result of the installation of products and systems prior to the approval of applicable shop drawings by the Department's Representative shall be provided at the Contractor's expense.
  2. Preparation:
    - a. Review each Mechanical Divisions 20, 21, 22, 23 and 25 specification section and identify the project's shop drawing requirements.
    - b. Combine the shop drawing requirements first by system (i.e. ventilation system, heating system, etc.) and then by area (i.e. fan room, boiler room, etc.).
    - c. Prepare shop drawings on full sized sheets of the same size as the original construction drawings.
    - d. Arrange shop drawings to scale, showing dimensions where accuracy of location is necessary for coordination or communication purposes.
    - e. Incorporate the actual dimensions and configurations of the products and systems approved through the product submittal process into the shop drawings.
    - f. Provide dimensioned maintenance clearance areas around each product as recommended by the manufacturer.
    - g. Meet with and coordinate Mechanical Divisions 20, 21, 22, 23 and 25 work with the interrelated work of other trades including Architectural, Civil, Structural, and Electrical to identify and resolve potential conflicts.
    - h. Clearly identify and provide recommendations to resolve major conflicts which may impact the design of the systems as shown. Such conflicts will be resolved during the shop drawing review process.
  3. Shop Drawing Submittal:
    - a. Submit dimensioned shop drawings as specified to demonstrate proper planning and sequencing of the applicable trades for the installation and arrangement of Mechanical Divisions 20, 21, 22, 23 and 25 with respect to other interrelated work.
    - b. Partial shop drawings Submittals (i.e. heating system only) will be rejected without review, as the interrelationship with other related work and overall system fit cannot be evaluated.
    - c. It is assumed that shop drawings submitted for review have been thoroughly prepared and coordinated as specified. Conflicts which are not clearly identified and annotated on the submitted shop drawings are assumed not to exist and that the products and systems can and shall be installed as shown.
    - d. Installation conflicts arising from the failure to properly coordinate the work of related trades shall be provided at the Contractor's expense.
- F. Commissioning Submittals
1. Provide Commissioning Submittals in accordance with Section 01 91 00 – Commissioning.

- G. Record Drawings:
1. General: As the Work progresses, neatly annotate a designated and otherwise unused, set of Mechanical Divisions 20, 21, 22, 23 and 25 Contract Drawings to show the actual locations and routing of Mechanical Divisions 20, 21, 22, 23 and 25 Work and the terminal connection points to related Work. As a minimum, include the following:
    - a. Annotate record drawings to incorporate each applicable addendum.
    - b. Annotate record drawings as directed by each applicable Request for Information (RFI) and accepted Change Order Proposal.
    - c. Modify record drawings to show actual equipment sizes and locations and pipe and duct routing. Revise pipe and duct sizes as appropriate.
    - d. Provide fully dimensioned locations for permanently concealed piping and ductwork (i.e. piping cast in concrete or buried underground/underslab).
    - e. Show the actual locations of system isolation valves, especially valves which are concealed above ceilings and behind access panels.
  2. Preparation:
    - a. Neatly annotate record drawings to provide clear interpretation to support electronic drafting by a third party.
    - b. Tape electronic sketches from addendums and/or RFIs directly to the record drawings as overlays.
    - c. Annotate the record drawings in colored pencil using the same symbols and abbreviations as indicated in the Mechanical Divisions 20, 21, 22, 23 and 25 legends and schedules of the Contract Drawings.
      - 1). Red to add information.
      - 2). Green to delete information.
      - 3). Blue to provide additional clarifying information which is not to be drafted.
    - d. After submittal to the Department's Representative, provide additional clarification, information or rework as necessary to support the accurate interpretation and electronic drafting of the record drawings.
  3. Submittals:
    - a. Provide dimensioned underslab record drawings to the Department's Representative prior to pouring the slab. For slabs poured in multiple sections, provide record drawings for the applicable slab sections to the Department's Representative prior to each pour.
    - b. Provide complete record drawings for concealed areas (i.e. above lay-in and hard ceilings and inside walls) to the Department's Representative prior to concealment.
    - c. Provide the remaining portion of the record drawings for exposed areas to the Department's Representative prior to the final completion of the project.
- H. Test Certificates:
1. Review the submittal requirements for Quality Control/Control Submittals for each specification section.
  2. Submit copies of design data, test reports, certificates, manufacturer's instructions and field test reports as specified. This information may be included within the Operations and Maintenance (IO&M) Manuals as determined by the Department's Representative.
- I. Operations and Maintenance (IO&M) Manuals:
1. Provide specific product IO&M information for each section as detailed within Mechanical Divisions 20, 21, 22, 23 and 25.
  2. Begin the preparation of the mechanical Operation and Maintenance Manuals with a complete and fully approved set of mechanical product Submittals organized, annotated and with the product information as indicated within the "Product Submittals" article for each specification section.
  3. Next, augment each individual product submittal with the written installation, operations and maintenance information for each specific product. Obviously, this type of information is not applicable (or available) for bulk commodity or simplistic products such as copper pipe, basic pipe hangers or equipment tags, etc.

4. Maintenance information shall include:
  - a. Preventive maintenance requirements for each product, including the recommended frequency of performance of each preventive maintenance task.
  - b. Instructions for troubleshooting, minor repair and adjustments required for preventive maintenance routines, limited to repairs and adjustments that may be performed without special tools or test equipment and that require no extensive special training or skills.
  - c. Information of a maintenance nature covering warranty items, etc., that have not been discussed in the manufacturers' literature.
  - d. Information data for the spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
5. Organize the Operation and Maintenance Manual information by specification section (not by sub-contractor) with a tabbed divider separating each section. Provide the typed section number on each tab.
6. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable section. Provide sub-tabs within each section for each product. Provide the typed product article number on each tab.
7. Bind the information in identical, 3" wide; hard-backed loose-leaf 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.
8. Provide a master table of contents at the front of each volume which lists the Mechanical Divisions 20, 21, 22, 23 and 25 specification sections and indicates which sections are located within each volume.
9. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
10. Provide identical cover and spine inserts for each IO&M manual volume.
11. For multiple volumes, label each volume.
12. Include the following typed information on the front cover and spine inserts of each volume:
  - a. The Department's Representative's Name.
  - b. Project Name.
  - c. "Mechanical Operations and Maintenance Manual".
  - d. "Volume 1 of X, Volume 2 of X," etc.

## 1.6 QUALITY CONTROL

- A. Qualifications:
  1. Perform the Work using qualified workmen that are experienced and usually employed in the trade.
- B. Product Testing and Certification:
  1. Where the words Listed, UL Listed, UL Labeled, Underwriters Laboratories, Inc., UL, or variations of this terminology, appear under this Division of the Specifications or the associated drawings, it is understood that a comparable testing agency as defined in the International Building Code is an acceptable substitute.
  2. Such testing and certification is generally applicable to products within the following categories.
    - a. Life safety and Fire Protection.
    - b. Fuel burning equipment, except certain classes of power or industrial equipment for which other recognized certification applies as well.
    - c. Factory fabricated and wired electrical control panels and packaged equipment with factory installed electrical controls or panels.
    - d. Components for life safety systems, fuel systems and medical gas systems.
  3. The listing under Paragraph 'B' above is provided for illustration of requirements and is not exclusive. Provide products that have been tested and listed for the intended application when such products are available unless the Department's Representative

- has provided written exemption on an itemized basis. Provide electrical products listed and labeled, or if not a listed product, designed and sealed by an Alaska Registered Professional Engineer, to the satisfaction of the Authority Having Jurisdiction.
4. Where interpretation is required, the Department's Representative will provide direction and will be the sole judge in cases of compliance with this subsection.
- C. Drawings and Specifications:
1. The Drawings and specifications are complementary. Do not scale the Drawings. Locations of products are approximate unless dimensioned.
  2. The Drawings are partly diagrammatic and do not show all offsets in piping or ducts, or exact location of products, and may not show in minute detail all features of the installation; however, provide systems complete and in proper operating order.
  3. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry. Special items are identified by a supplementary list of graphical illustrations, or called for on the Drawings or in the specifications.
- D. Tests and Inspections:
1. The Department's Representative may inspect and approve sample installation of systems and equipment prior to general installation of units.
  2. Schedule, obtain, and pay for fees and/or services required by the local Authorities Having Jurisdiction and by these specifications, to test the mechanical systems.
  3. Request for Tests: Notify the Department's Representative a minimum of 24 hours in advance of tests. Certify in writing that specified tests have been made in accordance with the specifications.
  4. Deficiencies: Immediately correct deficiencies that are evidenced during the tests and repeat tests until system is approved. Do not cover or conceal piping, equipment or other portions of the mechanical installations until satisfactory tests are made and approved.
  5. Operating Tests: Under the direction of the Contractor and in the presence of the Department's Representative, place the entire mechanical installation and/or any portion thereof in operation to demonstrate satisfactory operation.
  6. Test Witness: Arrange for the Department's Representative to witness tests. The Department's Representative may waive witnessing any specific test at its discretion.

## 1.7 ELECTRICAL WORK

- A. Provide equipment electrical panels and packaged line voltage control panels listed and labeled by UL, FM, ETL or other approved testing agency. If listing and labeling is not available, stamp the submittal drawings for these panels by a licensed Registered Professional Engineer approved by the Municipality, at no additional cost.
- B. Furnish each three phase motor 25 HP and larger, not already provided with equivalent protection via the controls system, with phase failure and phase reversal monitoring relay in all three phases and other features specified below. Relay shall open motor starter contacts at 10 percent voltage unbalance and shall automatically reset when voltage returns to normal. Adjustable time delay set at 0.2 second on dropout to prevent nuisance tripping on momentary voltage dips. Additional adjustable time delay set at 1 minute on pickup to allow Motors (25 HP and larger) to stop prior to restarting. Provide red indicating lights with "phase failure" and "phase reversal" nameplates.
- C. Furnish two-speed starter to suit motor for two-speed Motors. Starter to be installed under Divisions 26, 27 and 28.
- D. Suggested Coordination Schedule: The Contractor is responsible to provide heating, ventilating, plumbing and controls including Fire Protection controls. Unless otherwise indicated on the Drawings, it is recommended that Motors and controls be furnished, set in place, and wired in accordance with the following schedule. "CC" applies to either a Control subcontractor working as a sub to the General Contractor or to the Mechanical Divisions 20, 21, 22, 23 and 25 Mechanical subcontractor. Carefully coordinate work between subcontractors.

MC - Divisions 20, 21, 22, 23, 25 - Mechanical FP - Divisions 20, 21, 22, 23, 25 - Fire Protection CC - Divisions 20, 21, 22, 23, 25 - Controls EC - Divisions 26, 27 and 28 - Electrical	Furnished By	Set in Place By	Power By	Control By
Equipment Motors	MC	MC	EC	CC
*Magnetic motor starters:				
Automatic controlled, w/ or w/o HOA switches	EC	EC	EC	CC
Automatic controlled, w/ or w/o HOA switches, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
*Manual Motor Starters:				
Manually controlled	EC	EC	EC	EC
Manually controlled, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
Combination disconnect and motor starter	EC	EC	EC	CC
Motor Control Centers	EC	EC	EC	CC
Variable Speed Drives	MC	EC	EC	CC
Push-button stations, pilot lights, contactors, multi-speed switches	EC	EC	EC	EC
Disconnect switches, thermal overload switches, manual operating switches	EC	EC	EC	--
Multi-speed switches furnished as part of factory wired equipment	MC	MC	EC	MC
Temperature control relays, transformers, electric thermostats, time clocks, etc., that are not part of factory furnished equipment	CC	CC	CC	CC
Remote bulb thermostats, motor valves, controls, which are an integral part of factory furnished mechanical equipment.	MC	MC	EC	MC
Fire sprinkler protection controls	FP	FP	EC	FP
Duct smoke detectors, including relays for fan shutdown	MC	MC	EC	EC
Fire/Smoke Dampers	MC	MC	EC	EC
Building Automation and Control Systems	CC	CC	CC	CC
Master Building Power quality monitors (loss/reversal)	EC	EC	EC	CC
Water heater controls, internally wired	MC	MC	EC	MC

\* Provide starters in accordance with the Electrical Divisions 26, 27 and 28 of these Specifications. Note that a thermal overload relay in each phase is required for each starter (packaged equipment included).

### **1.8 SPARE PARTS**

- A. Furnish spare parts for systems and equipment as listed in applicable sections of Mechanical Divisions 20, 21, 22, 23 and 25.
- B. Clearly label each part with name, manufacturers part number, system and/or equipment where used and location.
- C. Deliver parts to location and person designated by the Department's Representative, in durable storage boxes.
- D. Group cartons containing smaller items by system or application and deliver in an appropriate number of storage boxes.

### **1.9 SPECIAL TOOLS**

- A. Provide three sets of special tools, and testing and monitoring equipment required in other sections of Divisions 20, 21, 22,23 and 25.

### **1.10 WARRANTY**

- A. Refer to Division 1 for general warranty requirements.
- B. Warranty workmanship, labor, and materials for a period of one year from the date of final acceptance, without limitation, except where longer warranty periods are specified in a specific Section under this, or in the General Conditions of the Contract. Promptly coordinate and perform Warranty work at the Contractor's sole expense.

## **PART 2 - PRODUCTS - NOT USED**

## **PART 3 - EXECUTION**

### **3.1 COORDINATION WITH ROOM NUMBERING**

- A. Certain systems provided under this Division rely on identification systems that are based on room names or numbers.
- B. The numbering scheme indicated in these Contract Documents is based on room numbers assigned during the design process. The Department's Representative reserves the right to change the numbers prior to Substantial Completion, and the final names and numbers will not necessarily match those found in the Contract Documents. Obtain from The Department's Representative the final room numbers prior to commencing the numbering of Divisions 20, 21, 22, 23 and 25 systems. Tag and label system equipment and devices in accordance with the final numbering scheme at no additional cost.

### **3.2 LIMITATIONS OF EQUIPMENT DURING CONSTRUCTION**

- A. Cover and protect open ends and individual components of the HVAC systems during construction when dust, dirt, debris, overspray, or other construction potential contaminates could enter the air distribution system or elements, (ducts, Fans, VAV boxes, silencers, etc.).
- B. Provide temporary construction filters over return airshaft openings and at air handling unit return air dampers.
- C. Prior to Commissioning, clean equipment and HVAC ductwork systems used during construction, in accordance with Section 23 40 01 - Duct Cleaning. Cover ductwork and equipment during storage. Cover end of pipes and ducts during construction.
- D. Provide temporary heating to maintain the building at 65 degrees F., and temporary ventilation with filtration during construction.

### **3.3 CLEANING AND REPAIR**

- A. Clean and repair existing materials and equipment that remain or are to be reused or are affected by this work.

- B. Plug, patch and repair surfaces, adjacent construction, and finishes damaged during demolition and new work. Restore to original condition or better. Retexture surfaces to match surrounding surfaces. Repaint affected surfaces, with extent of paint to include adjacent surfaces to next wall or other clean break to avoid mismatched finish. Repair fire proofing.

**END OF SECTION 20 00 00**

**SECTION 20 05 29**  
**HANGERS AND SUPPORTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Pipe and equipment Hangers and Supports.
  - 2. Equipment bases and supports.
  - 3. Sleeves and seals.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 07 00 - Mechanical Insulation
  - 5. 22 11 00 - Domestic Water Piping and Specialties
  - 6. 22 14 00 - Sanitary Waste and Vent Piping
  - 7. 22 14 23 - Storm Drainage Piping
  - 8. 22 15 13 - Compressed Air Systems
  - 9. 22 40 00 - Plumbing Fixtures
  - 10. 23 11 13 - Fuel Oil Piping and Specialties
  - 11. 23 13 23 - Aboveground Storage Tanks
  - 12. 23 21 13 - Hydronic Piping and Specialties
  - 13. 23 21 14 - HVAC Pumps
  - 14. 23 31 00 - Ducts and Accessories
  - 15. 23 34 00 - Fans
  - 16. 23 35 00 - Industrial Ventilation Systems
  - 17. 23 36 00 - Air Terminal Units
  - 18. 23 36 16 - Laboratory Ventilation Systems
  - 19. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 20. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 21. 23 64 00 - Packaged Water Chillers
  - 22. 23 70 00 - Central Air Handling Units
  - 23. 23 72 13 - Dedicated Outside Air Units
  - 24. 23 81 00 - Storage Vault HVAC Equipment
  - 25. 23 81 16 - Room Air-Conditioning Units
  - 26. 23 82 00 - Terminal Heating and Cooling Units
  - 27. 23 83 00 - Radiant Floor Heating Equipment
  - 28. 23 83 01 - Snow Melting Equipment
  - 29. 23 84 00 - Humidification Equipment
  - 30. 25 50 00 - Building Automation and Control
  - 31. 25 55 00 - Variable Speed Drives

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. International Mechanical Code (IMC).
- C. Uniform Plumbing Code (UPC).
- D. MSS SP69 – Pipe Hangers and Supports – Selection and Application.
- E. MSS SP89 – Pipe Hangers and Supports – Fabrication and Installation Practices.
- F. SMACNA HVAC Duct Construction Standards – Metal and Flexible (current edition).

### 1.3 DESCRIPTION

- A. This section applies Mechanical Divisions 20, 21, 22, 23 and 25 equipment and systems:
  - 1. Support Fire Protection System piping and equipment accordance with the provisions of Section 21 11 00 - Domestic Water Piping and Specialties.
  - 2. Support plumbing piping in accordance with this section and Uniform Plumbing Code requirements; whichever is more restrictive. If case of conflicts, follow UPC guidance.
  - 3. Support ductwork in accordance with Section 23 31 00 - Ducts and Accessories.
- B. Design Requirements
  - 1. Equipment and piping system support.
    - a. Select and apply pipe Hangers and Supports per MSS SP69 using stock or production parts whenever possible.
    - b. Design support spacing such that free span of piping does not exceed Code or MSS SP69 criteria (whichever is most restrictive).
    - c. Calculate required supporting force at each hanger location to confirm hanger type and hanger rod diameter selection.
    - d. Provide hangers such that equipment connection points do not carry connected piping load.
  - 2. Vibration and seismic restraint systems.
    - a. Coordinate the requirements of this section with Section 13 48 00 - Vibration and Seismic Control.
- C. Performance Requirements
  - 1. Provide Hangers and Supports which allow for the free expansion and contraction of system piping without transferring tensile and compressive stresses to adjacent supports or connected equipment. Provide additional expansion loops, pipe anchor and pipe guide assemblies as required.
  - 2. Coordinate hanger and support anchor locations and embedment depth requirements with structural.
  - 3. Provide flexible connectors for piping systems which pass through seismic building joints. Design flexible connects for design building offset plus 100 percent safety factor.
- D. Special Performance Requirements for Opened Ceiling Spaces
  - 1. Coordinate the support of piping, ductwork, lighting and electrical cabling in open ceiling spaces (utilizing the shop drawing review process) to provide a uniform and symmetrical appearance.
  - 2. In general, utilize trapeze hanger style support systems with hangers equally spaced based on the limiting component being supported. Provide hanger rods vertical and straight. Trim hanger rod ends to provide a "finished" appearance.

### 1.4 SUBMITTALS

- A. Product Data:
  - 1. Provide manufacturers catalog data, including load capacity, embedment depth.
  - 2. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- B. Shop Drawings:
  - 1. Provide shop drawings for housekeeping pads and roof curbs (with dimensioned penetrations) and field fabricated support systems.
  - 2. Provide shop drawings to show system layout with location and detail of hangers, anchors, dimensioned expansion loops and guides. Coordinated with Section 13 48 00 Vibration and Seismic Control shop drawing submittal.
- C. Project Record Information:
  - 1. Indicate installed locations of hangers, supports and expansion control assemblies on record drawings on associated piping record drawings.

2. Provide Operating and Maintenance Data (installation and adjustment instructions) for non-commodity products.

### **1.5 QUALITY CONTROL**

- A. Provide piping and support systems designed and manufactured per MSS SP58.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Acceptance at Site:
  1. Verify products are delivered in original factory packaging and are free from damage and corrosion.
  2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Department.
- B. Storage and Protection:
  1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

### **1.7 WARRANTY**

- A. Provide warranty in accordance with Section 20 00 00 – Mechanical General Requirements.

## **PART 2 - PRODUCTS**

### **2.1 PIPE HANGERS AND SUPPORTS**

- A. General:
  1. Piping and support systems shall be malleable iron, steel or copper.
  2. Ferrous Hangers and Supports installed outdoors or in unheated spaces shall be hot dipped galvanized.
  3. Select and apply pipe Hangers and Supports per MSS SP69.
    - a. Use stock or production parts whenever possible.
    - b. Calculate weight balance to determine the required supporting force at each hanger location and to eliminate pipe weight load at each equipment connection.
  4. Fabricate and install pipe Hangers and Supports per MSS SP89 recommended practices.
  5. Hangers shall be designed to securely lock using a mechanical fastener. Hangers and Supports using gravity type locking are not acceptable. For example, adjustable swivel ring Type 6 is not allowed.
  6. Pre-engineered support systems such as Unistrut, Super-Strut, B-Line and K-Line may be used in accordance with manufacturers load limits.
  7. Manufacturers: Grinnell, M-CO Michigan Hanger Company, Kin Line.
- B. Plumbing Piping:
  1. Conform to the Uniform Plumbing Code requirements.
  2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.
  3. Hangers for DWV and Cold Pipe Sizes two inch and over: Carbon steel, adjustable, clevis.
  4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.
  5. Hangers for Hot Pipe Sizes six inches and over: Adjustable steel yoke, cast iron roll, double hanger.
  6. Multiple or Trapeze Hangers under six inches: Steel channels with welded spacers and hanger rods.
  7. Multiple or Trapeze Hangers for Hot Pipe Sizes six inches and over: Steel channels with welded spacers and hanger rods, cast iron roll.
  8. Wall Supports: Welded steel bracket and wrought steel clamp.
  9. Wall Support for Hot Pipe Sizes six inches and over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

10. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
11. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
12. Floor Support for Hot Pipe Sizes six inches and over: Adjustable cast iron roll and stand, steel screws, and steel support.
13. Vertical Support: Steel riser clamp.
14. Provide copper plated Hangers and Supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Hydronic Piping:

1. Conform to ASME B31.9 and the International Mechanical Code.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.
3. Hangers for Cold Pipe Sizes two inches and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe sizes six inches and over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes six inches and over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support: Welded steel bracket and wrought steel clamp.
9. Wall Support for Hot Pipe Sizes six inches and over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
12. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
13. Floor Support for Hot Pipe Sizes six inches and over: Adjustable cast iron roll and stand, steel screws, and steel support.
14. Provide copper plated Hangers and Supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Refrigerant Piping:

1. Conform to ASME B31.5.
2. Hangers for pipe sizes 1/2 to 1-1/2 inch: Adjustable swivel ring, split ring.
3. Hangers for pipe sizes two inches and over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
8. Provide copper plated Hangers and Supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## 2.2 ACCESSORIES

- A. Hanger Rods: Mild steel, threaded both ends, threaded one end, or continuous threaded.
- B. Escutcheons: Nickel or chrome plate with screws or springs for holding plate in position.
- C. Pipe Protection Saddles: Shop fabricates, or purchase specially manufactured saddles specifically designed for the intended use. Provide saddles where roller type support is used, or where the pipe hanger is installed outside the insulation for protection of insulating jacket.
- D. Outdoor applications: Metal components shall be galvanized.

### 2.3 INSERTS

- A. Provide inserts to match the load bearing capacity of hangers scheduled in Part 3.
- B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over four inches.
- C. Concrete deck inserts: Galvanized rod, steel plate, similar to Kin-Line figure 293.
- D. Screw insert for concrete: Malleable iron similar to Grinnell figure 152.

### 2.4 PRE-ENGINEERED SUPPORT SYSTEMS

- A. Manufacturers:
  - 1. Unistrut
  - 2. Super-Strut
  - 3. B-Line
  - 4. K-Line
  - 5. Erico.
- B. Material:
  - 1. Cold worked steel.
  - 2. Type 304 stainless steel: Use for PVC, liquid-tight flex, or plastic-coated conduit installed to wood construction in outdoor, damp, corrosive or marine environments.
- C. Finish:
  - 1. Heated indoor areas: Pre-galvanized zinc coating.
  - 2. Outdoor areas: Hot dipped galvanized finish. In addition, coat hot dipped galvanized finish channel field cuts with zinc rich paint provide by the support system manufacturer.
  - 3. Painted areas: Paintable galvanizing or phosphatized and primed.
  - 4. Surface metal raceways: U.L. Listed epoxy coating.
- D. Channel:
  - 1. Standard Size: 1-5/8 inch x 1-5/8 inch. Gauge thickness as required for attached load.
  - 2. Standard Hole Pattern: Slotted. Provide solid channel in exposed public areas.
- E. Nuts and Hardware:
  - 1. Channel nuts: Hardened steel (ASTM-A675 and ASTM A36).
  - 2. Bolts, screws and nuts: Hardened steel (ASTM-A307, ASTM A563 and SAE J429).
  - 3. Finish: Electroplated zinc
- F. Fittings: Plate steel (ASTM A635). Epoxy or electroplated zinc coating
- G. Mechanical Accessories: Provide accessories from the support system manufacturer designed for the specific equipment to be supported to include but not limited to:
  - 1. Splice and gusset plates.
  - 2. Corner angles.
  - 3. Specialized support brackets.
  - 4. Beam clamps with restraints.
  - 5. Column supports.
  - 6. Strut pipe clamps.
  - 7. Straps.
  - 8. Brackets

### 2.5 EQUIPMENT ROOF CURBS

- A. Provide field fabricated roof curbs for roof mounted dedicated outside air units and cold room condensers. See Architectural.
- B. For other roof mounted equipment (provide pre-manufactured insulated roof curbs from the same manufacturer as the equipment being mounted. See applicable specification sections.

## 2.6 SLEEVES

- A. Fabricate pipe sleeves as follows:
  - 1. In bearing walls, foundations, masonry or concrete walls and slabs, use schedule 40 black steel pipe. Cast iron pipe through floor slab or grade may be cast in place.
  - 2. In frame or similar construction, use 20 gauge galvanized sheet metal with edges turned 1/2 inch.
  - 3. Sleeves for Pipes through Non-fire Rated Floors: Eighteen (18) gauge galvanized steel.
- B. Sleeves for pipes through fire rated and fire resistive floors and walls, and fire proofing: UL listed prefabricated fire rated sleeves and seals.
- C. Sleeves for round ductwork: Galvanized steel.
- D. Sleeves for rectangular ductwork: Galvanized steel.

## 2.7 WALL/FLOOR PENETRATION WATER SEALS

- A. Mechanical seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
- B. EPDM seals
- C. 316 Stainless steel bolts and nuts.
- D. Hot-dipped galvanized sleeve with full water stop flange with continuous weld on both sides.
- E. Manufacturer: Thunderline Link-Seal, Crouse-Hinds Link-Seal, or equal.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Prior to installation, prepare detailed shop drawings for the installation of hanger and support products specified by this section. Coordinate the location, type and size of Hangers and Supports, housekeeping pads (thickness/perimeter overhang dimensions) and roof curbs utilizing the shop drawing review process.
- B. Submit shop drawing required by this section along with the seismic design and associated shop drawings required by Section 13 48 00 - Vibration and Seismic Control as a single submittal.
- C. Do not install Hangers and Supports without approved shop drawings.

### 3.2 PIPE HANGER AND SUPPORT INSTALLATION

- A. Install Hangers and Supports in accordance with manufacturer's instructions, applicable Code requirements and approved shop drawings.
- B. Support horizontal piping as scheduled.
- C. Independently support piping at equipment, so that the equipment supports no weight.
- D. Insulated piping shall have insulation saddles or 18 gauge steel insulation shields combined with sections of calcium silicate or cellular glass. Cold piping shall always be supported over the insulation and vapor barrier. Subject to approval, hot piping may be insulated around the supports.
- E. Trapeze hangers shall be used when more than three pipes run parallel and at same elevation. Provide rollers for hot pipes. Design rods and cross members to support three times the weight of pipes and contents plus 250 pounds.
- F. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
- G. Place hangers within 12 inches of each horizontal elbow.
- H. Use hangers with 1-1/2 inch minimum vertical adjustment.

- I. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between hangers.
- J. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- K. Support riser piping independently of connected horizontal piping.
- L. Provide saddles where roller type support is used, or where the pipe hanger is installed outside insulation for protection of insulating jacket.
- M. Piping requiring Vibration Isolation:
  - 1. Coordinate with Section 13 48 00 for piping requiring vibration isolation.
  - 2. Support main risers less than 20 ft. in height only at mid level, with riser guides at other levels.
  - 3. Do not support vibration isolated piping along with non-isolated piping on a common trapeze.
  - 4. Rigidly mount steel spring hanger boxes to the supporting structure. Do not locate in the middle of the hanger rod.
  - 5. Rigid pipe anchors are not permitted in vibration isolated piping circuits. When pipe anchors are required.

### **3.3 INSERTS AND ATTACHMENT INSTALLATION**

- A. Caution: Project contains cast in place radiant floor heating tubing. Coordinate slab penetration locations so as not to damage tubing.
- B. Make hanger and support attachments to structure.
- C. Provide inserts or cast-in-place channels for placement in concrete formwork.
- D. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- E. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- F. Structural steel clamps shall engage both sides of structural member or have retaining clips or other approved means for positive engagement.
- G. Use expansion type anchor bolts with pre-cast concrete including concrete masonry units within loading limits of the pre-cast material and anchor bolt manufacturer's recommendations.
- H. 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.
- I. Powder-driven studs shall be used only with prior approval and not in tension.
- J. Plastic screw inserts and caulked lead inserts are prohibited, except for mounting instructions and control diagrams.

### **3.4 EQUIPMENT BASES AND SUPPORT INSTALLATION**

- A. Refer to Section 03 30 00 for Cast-in-Place Concrete requirements.
- B. Provide 5-1/2 inch (2x6 forms) concrete housekeeping pads for floor mounted Central Air Handling Units. Coordinate perimeter overhang dimensional requirements (12 inches typical) with Section 13 48 00 - Vibration and Seismic Control such that air handler anchor bolts achieve proper embedment.
- C. Provide 3-1/2 inch (2x4 form) concrete housekeeping pads for all other floor mounted mechanical equipment. Coordinate perimeter overhang dimensional requirements (8 inches typical) with Section 13 48 00 such that equipment anchor bolts achieve proper embedment.
- D. Construct field fabricated equipment bases and supports from steel members and/or pre-engineered support systems. Prime and paint bases and supports black in accordance with Section 09 90 00 – Painting. Pre-engineered support systems which are factory coated are not required to be painted.

### 3.5 ROOF CURB INSTALLATION

- A. Coordinate with Architectural and provide roof curb locations and dimensional and support requirements for roof mounted equipment. Provide insulation within the roof curb boundary to match the adjacent roof R-value.
- B. Pre-engineered roof curbs are specified with the equipment being mounted. See applicable specification sections.

### 3.6 EQUIPMENT INSTALLATION

- A. Provide hardware and accessories necessary to mount fixtures and equipment. Adapt to field conditions.
- B. Securely fasten fixtures and equipment to the building structure in accordance with the manufacturer's installation recommendations.
- C. Provide fabricated steel supports frames and bases for equipment not directly mounted on floor. For belt driven equipment provide rigid structural base in common with motor to maintain belt tension.
- D. Provide steel base plates for floor mounted fixtures and equipment to distribute the weight such that the floor load is not more than 100 PSF, unless special structural reinforcement is submitted for approval.
- E. At wall attached fixtures and equipment weighing less than 50 pounds, provide backing plates at least 1/8 by 10 inch square sheet steel or two by 10 inch fire retardant treated wood securely built into the structural walls. Submit attachment details of heavier equipment for approval.
- F. Painted fabricated steel support black in accordance with Section 09 90 00 - Painting.

### 3.7 WALL PENETRATION WATER SEALS

- A. Provide wall penetration water seals where shown.
- B. Provide manufacturer's water-stop sleeve for use with seal. Size sleeves in accordance with manufacturer's installation instructions. Coordinate installation of sleeves in cast concrete wall with Structural.

### 3.8 PENETRATIONS

- A. Coordinate completely with architectural and structural construction details, and provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation of mechanical penetrations.
- B. Detail sleeves, curbs, flashings, storm collars, and closures to be compatible with adjacent architecture. Provide penetrations through roof, outside walls and floors to be watertight and weather tight under all circumstances.
- C. Fire-stopping: See Division 7.
- D. Acoustical Sealing:
  - 1. In monolithic sound walls such as poured concrete or masonry, provide a sleeve with approximately one-inch annular space around the pipe. Pack the annular space with backer rod or acoustical filler as specified in Division 7. Allow a 1 inch recess at each end of sleeve and caulk sleeve flush with flexible sealant or firestopping material as specified in Division 7.
  - 2. Where acoustical wall is a two component type, such as a staggered or double stud partition, treat each component as a separate wall. Pack and seal each half of penetration sleeve as previously specified, except that only the exposed end of each sleeve portion can be caulked with sealant or fire-stop. Provide adequate separation between each sleeve.

- E. For sleeves through mullions, forming members and similar construction, provide Acorn Trisolators.

### **3.9 WALL PENETRATION WATER SEAL INSTALLATION**

- A. Coordinate installation of sleeves in cast concrete wall with Structural prior to installation.
- B. Provide wall penetration water seals for exterior wall penetrations. Include manufacturer's water-stop sleeve for use with seal as applicable.
- C. Size sleeves in accordance with manufacturer's installation instructions.
- D. Install piping and seal prior to waterproofing the wall. Grout void between water seal and outside face of foundation wall to provide continuous bearing surface for waterproofing fabric.

### **3.10 FLOOR PENETRATION WATER SEAL INSTALLATION**

- A. Provide floor penetration sleeves and water seals for all floor penetrations in penthouse fan room floors to include but not limited to piping, ductwork and electrical/building automation system conduit.
- B. Extend sleeves to 3 inches above finished floor.

### **3.11 FLASHING**

- A. Provide EDPM pipe penetration and roof curb flashing in accordance with Division 7 for Single-Ply EDPM Membrane Roofing as an integral part of the roofing system.

### **3.12 SLEEVES**

- A. Provide sleeve where pipes pass through walls, floors, or ceilings.
- B. Install sleeves flush with surfaces, except mechanical rooms or any wet floor where seepage may occur, install 1-inch above floor.
- C. Waterproof sleeves through building exterior skin, including walls, floors and roofs, to prevent leakage.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Size sleeves for cold piping to allow continuous insulation through sleeve.
- F. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- G. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- H. Provide escutcheons on pipes passing through walls, floors, and ceilings in finished areas and where piping is in counters, closets, or cabinets, and subject to view when doors are open. Cover the pipe sleeve and secure plate in position.
- I. Provide Acorn Trisolators for sleeves through mullions, forming members and similar construction.

**3.13 SCHEDULES**

- A. Pipe Support: Provide pipe support spacing as indicated in the table below except where spacing more restrictive by Code.

PIPE SIZE (Inches)	HANGER SPACING MAX (Feet )			
	Steel		Copper	Polyethylene (1)
	Water Filled	Gas Filled		
1/2	7	9	5	
3/4	7	9	5	
1	7	9	6	
1-1/4	7	9	7	
1-1/2	9	12	8	4
2	10	13	8	4-1/2
2-1/2	11	14	9	
3	12	15	10	5
4	14	17	12	6
6	17	21	14	
8	19	24	16	

(Based on Table 3, MSS SP-69, except for PE piping)  
(1)(Based on manufacturer's data)

**3.14 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

**END OF SECTION 20 05 29**

**SECTION 20 05 53**  
**MECHANICAL IDENTIFICATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Equipment nameplates.
  - 2. Valve tags and fasteners.
  - 3. Pipe markers.
  - 4. Ceiling tacks.
  - 5. Painting of bare and insulated piping systems.
- B. Related Sections:
  - 1. 09 90 00 - Painting
  - 2. 20 07 00 - Mechanical Insulation
  - 3. 21 11 00 - Fire Protection
  - 4. 22 11 00 - Domestic Water Piping and Specialties
  - 5. 22 11 23 - Packaged Lift Station
  - 6. 22 14 00 - Sanitary Waste and Vent Piping
  - 7. 22 14 23 - Storm Drainage Piping
  - 8. 22 15 13 - Compressed Air Systems
  - 9. 22 40 00 - Plumbing Fixtures
  - 10. 23 11 13 - Fuel Oil Piping and Specialties
  - 11. 23 13 23 - Aboveground Storage Tanks
  - 12. 23 21 13 - Hydronic Piping and Specialties
  - 13. 23 21 14 - HVAC Pumps
  - 14. 23 31 00 - Ducts and Accessories
  - 15. 23 34 00 - Fans
  - 16. 23 35 00 - Industrial Ventilation Systems
  - 17. 23 36 00 - Air Terminal Units
  - 18. 23 36 16 - Laboratory Ventilation Systems
  - 19. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 20. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 21. 23 64 00 - Packaged Water Chillers
  - 22. 23 70 00 - Central Air Handling Units
  - 23. 23 72 13 - Dedicated Outside Air Units
  - 24. 23 81 00 - Storage Vault HVAC Equipment
  - 25. 23 81 16 - Room Air-Conditioning Units
  - 26. 23 82 00 - Terminal Heating and Cooling Units
  - 27. 23 83 00 - Radiant Floor Heating Equipment
  - 28. 23 83 01 - Snow Melting Equipment
  - 29. 23 84 00 - Humidification Equipment
  - 30. 25 50 00 - Building Automation and Control
  - 31. 25 55 00 - Variable Speed Drives

**1.2 DESCRIPTION**

- A. Paint exposed piping and pipe insulation in utility and mechanical rooms.
- B. Paint all exterior piping (prior to installing supports) for a continuous coating with epoxy coating systems.
- C. Provide labels for piping systems.
- D. Provide engraved tags for valves and engraved equipment nameplates for each piece of schedules equipment under this Contract.

**1.3 REFERENCES**

- A. ASME A13.1 (American Society of Mechanical Engineers) – Scheme for the Identification of Piping Systems.
- B. BS ENH 13792:2002 – Title Identifier, Color Coding of Taps and Valves for Use in Laboratories

**1.4 SUBMITTALS**

- A. General: Submit product data in accordance with Section 20 00 00 - Mechanical General Requirements and as further described by this article.
  - 1. Submit written master schedule of equipment, components and systems that will be tagged and labeled for the project.
  - 2. Include in the schedule, the proposed method of labeling to be implemented (nameplate, tag, marker, etc.), legend (“Domestic Cold Water,” “PMP-1,” etc.) and letter/background colors.
  - 3. Match legend to Contract Document legends, abbreviations and schedule symbols. Use standard Mechanical Identification products when available.
  - 4. Submit separate proposed “Valve Directories” (subset of the master schedule) for the central boiler room and each fan room which includes the valves located within the applicable space. Include valve designations, a brief description and normal position (open (NO), closed (NC), balanced to X GPM). For Example:

Valve Designator	Description	Normal Position
H-101	HX-1 Supply Isolation	NO
H-102	HX-1 Return Isolation	NO
H-103	HX-1 Flow Balance	150 GPM
P-100	Domestic Water Service Isolation	NO
P-201	Supply Strainer Flush Valve	NC
ETC.		

**1.5 CLOSEOUT SUBMITTALS**

- A. Section 20 00 00 - Mechanical General Requirements.
- B. Submit “Valve Directories” with balance valve settings as obtained from the final balance report.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Marking Services Incorporated (MSI).
- B. Seton Identification Products.
- C. Approved equal.

**2.2 EQUIPMENT NAMEPLATES**

- A. Plastic Engraved Equipment Nameplates:
  - 1. Minimum letter height: 3/4 inch.
  - 2. Tag size: Commensurate with specified lettering requirements. Provide uniform size for similar types of equipment.
  - 3. Thickness: 1/16 inch minimum.

4. Fastening method: Mounting holes. Adhesive backing may be provided for labeling equipment where drilling holes is not feasible with the pre-approval of the Department's Representative.
5. Color coding: As designated by the Department's Representative. If specific direction is not provided, select white letters on black background.
6. Legend: As designated by the Department's Representative. If specific direction not provided, match scheduled equipment symbols.

### 2.3 VALVE TAGS

- A. General:
  1. Provide tags for new mechanical system valves provided by the project.
  2. Provide tags for existing mechanical system valves to remain in boiler room and fan room areas.
  3. Provide tag top line legends (service indicators), using system abbreviations provided in Part 3 Pipe Identification Table.
  4. Start valve numbering with "001" for each legend series/service indicator. Assign valve numbers in a logical sequence from the source (i.e. service water entry point, gas meter service isolation or heat source (boiler or water heater supply) and continue numbering outward to the most remote terminal connection point.
- B. Plastic Engraved Tags:
  1. Round, 1-1/2 inches diameter, engraved plastic.
  2. Stamped and filled black with service indicator.
    - a. 1/4 inch service indicator on top.
    - b. 1/2 inch valve number below.
  3. Beaded chain tag fasteners.
  4. Provide tag color coding to match pipe marker coding or as designated by the Department's Representative.
- C. Brass Stamped Tags:
  1. Round, 1-1/2 inches diameter, brass with smooth edges.
  2. Stamped and filled black with service indicator.
    - a. 1/4 inch service indicator on top.
    - b. 1/2 inch valve number below.
  3. Beaded chain tag fasteners.
- D. Valve Chart Frame:
  1. 8-1/2" x 11" aluminum frame with plastic lens.
  2. Provide multiple frames as required.

### 2.4 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
  1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers:
  1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

### 2.5 CEILING TACKS

- A. Description: Steel with 3/4-inch diameter color-coded head.
- B. Color code as follows:
  1. HVAC equipment: Yellow.
  2. Plumbing valves: Green.
  3. Heating/cooling valves: Blue.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install identifying devices after completion of coverings and Painting.
- B. Do not install identifying devices over factory installed equipment labels.
- C. Provide new equipment nameplates, valve tags and pipe markers for the facilities mechanical systems.
- D. Locate identifying devices in clear view for simple identification.
- E. Small equipment, such as in-line pumps may be identified with tags in lieu of nameplates if inadequate room is available.
- F. Tag automatic controls, instruments, and relays. Key these to control schematic.
- G. Frame and install approved valve directories and one line diagrams for piping and instrumentation indicating instrument and valve ID numbers, mounted in noticeable locations in mechanical rooms at a location designated by the Department's Representative.
- H. Contractor to provide plastic laminated valve schedule

#### 3.2 PIPE PAINTING AND IDENTIFICATION

- A. Pipe Painting:
  - 1. Degrease and clean surfaces to be painted or directly receive adhesive pipe markers.
  - 2. Paint new and patched piping insulation exposed in utility areas and mechanical rooms white in accordance with Section 09 90 00 – Painting.
  - 3. Paint new and reworked bare steel piping exposed in utility areas and mechanical rooms black in accordance with Section 09 90 00 – Painting.
  - 4. Paint new bare steel piping exterior to the building gray in accordance with Section 09 90 00 – Painting.
  - 5. Do not paint non-ferrous piping/tubing, fittings or valves such as copper or bronze.
- B. Pipe Identification:
  - 1. Identify piping, concealed or exposed, using ANSI A13.1 compliant self-adhesive vinyl pipe markers. Identify both service and flow direction in accordance with the following Table.

Abbreviation	Legend	Color (Letters/Background)
CW	Domestic Cold Water	White/Green
HW	Domestic Hot Water	Black/Yellow
HWC	Domestic Hot Water Circ	Black/Yellow
NON-POTABLE CW	Non-Potable Lab Cold Water	White/Green
NON-POTABLE HW	Non-Potable Lab Hot Water	Black/Yellow
NON-POTABLE HWC	Non-Potable Lab Hot Water Circ	Black/Yellow
HWS	Heating Water Supply	Black/Yellow
HWR	Heating Water Return	Black/Yellow
GS	Glycol Heating Supply	Black/Yellow
GR	Glycol Heating Return	Black/Yellow
RL	Refrigeration - Liquid	Black/Yellow
RS	Refrigeration - Suction	Black/Yellow

Abbreviation	Legend	Color (Letters/Background)
W	Sanitary Drain	White/Green
V	Sanitary Vent	White/Green
RL, ORL	Rain Leader, Storm Drain	White/Green
F	Fire Protection Water	White/Red
CA	Compressed Shop Air	White/Blue

2. Install markers in unobstructed view and aligned with horizontal or vertical axis of piping as appropriate. For piping located above the normal line of vision, place markers below the pipes horizontal centerline for clear unobstructed view from below.
3. Install markers not to exceed 25 foot intervals along straight piping runs (including risers and drops), adjacent to each valve and tee, at each side of a "blind" penetration or obstruction.
4. Pipe labels are not required in public spaces unless specifically indicated.

**END OF SECTION 20 05 53**

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**SECTION 20 07 00**  
**MECHANICAL INSULATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. This section describes specific requirements, products and methods of execution which relate to the insulation of ducts, fittings, equipment, pipes and other surfaces of the mechanical installation.
- B. Related Sections:
  - 1. 09 90 00 - Painting
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 29 - Hangers and Supports
  - 4. 20 05 53 - Mechanical Identification
  - 5. 22 11 00 - Domestic Water Piping and Specialties
  - 6. 22 14 00 - Sanitary Waste and Vent Piping
  - 7. 22 14 23 - Storm Drainage Piping
  - 8. 22 40 00 - Plumbing Fixtures
  - 9. 23 21 13 - Hydronic Piping and Specialties
  - 10. 23 31 00 - Ducts and Accessories
  - 11. 23 36 16 - Laboratory Ventilation Systems
  - 12. 23 83 00 - Radiant Floor Heating Equipment
  - 13. 23 83 01 - Snow Melting Equipment

**1.2 DESCRIPTION**

- A. Provide thermal insulation for ventilation system ductwork and building service piping.
- B. Provide insulation for exposed ADA plumbing fixture piping.

**1.3 REFERENCES**

- A. International Building Code (IBC).
- B. International Energy Conservation Code (IECC)
- C. International Mechanical Code (IMC)
- D. ASHRAE Standard 90.1-Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. ANSI A117.1 - 1998 Accessible and Useable Buildings and Facilities.
- F. NFPA 90A -2002 Standard for the Installation of Air Conditioning and Ventilating Systems.
- G. NFPA 90B - 2006 Standard for the Installation of Warm Air Heating and Air Conditioning Systems

**1.4 SUBMITTALS**

- A. Product Data: Submit product description, thermal characteristics, list of materials/thickness, vapor barrier and jacketing for each insulation service application.
- B. Shop Drawings: Submit detail of building vapor retarder connection to the insulated cold air duct vapor retarder.
- C. Qualifications: submit manufacturer and Applicator qualifications, showing compliance with Article 1.5.

### 1.5 QUALITY CONTROL

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.
- B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years experience.

### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.

## PART 2 - PRODUCTS

### 2.1 FIRE RATING OF MATERIALS

- A. Provide insulation products used aboveground in building with burning characteristics in compliance with NFPA Standards 90A and 90B: Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Tested according to UL 723, ASTM E84, or NFPA 255
- B. Insulation specified for use underground and aboveground away from the building might have other burning characteristics. Use such products only where specifically required.

### 2.2 FIBERGLASS INSULATION

- A. Piping: Provide insulation products as follows:
  - 1. Thermal conductivity K equals 0.24 at 100 degrees F. mean temperature. ASTM C335.
  - 2. Factory applied vapor-barrier, flame retardant all service jacket and tape, with permeability rating equals 0.02 perms. ASTM E 96.
  - 3. Temperature limits for fiberglass pipe insulation: 350 degrees F, unless otherwise indicated.
  - 4. Manufacturers: Johns Manville, Owens Corning, Knauf Fiber Glass, or approved equal.
- B. Ductwork: Provide insulation products as follows:
  - 1. Flexible insulation: Average thermal conductivity K equals 0.24 at 75 degrees F. mean temperature at 1.5 pcf density. ASTM C335.
  - 2. Rigid insulation: Average thermal conductivity K equals 0.24 at 75 degrees F. mean temperature at 3.0 pounds per cubic feet (pcf) density. ASTM C518.
  - 3. Factory-applied vapor barrier flame-retardant Foil-Scrim-Kraft (FSK) or all-service jacket and tape, with permeability rating equals 0.02 perms. ASTM E 96.
  - 4. Temperature limits for fiberglass duct insulation: 250 degrees F. unless otherwise indicated.
  - 5. Manufacturers: Johns Manville, Owens Corning, Certainteed, Knauf Fiber Glass, or approved equal.
- C. Blank Type Insulation Covers:
  - 1. Utilize lace- up or snap buckle fabric covered insulation blanket type covers for all valves and fittings not covered with standard pipe insulation.
  - 2. Provide vapor retarder outside face of jacket for chilled water and domestic cold water.

### 2.3 RIGID PIPE INSULATION (AREAS SUBJECT TO FOOT TRAFFIC)

- A. Hydrous Calcium Silicate:
  - 1. Rigid type pre-formed to suit application.
  - 2. Thermal conductivity K = 0.40 at 200 degrees F.

### 2.4 LIMP MASS SOUND INSULATION

- A. Provide limp barrier material with a minimum performance of 15 DIL in the 2<sup>nd</sup> octave band, and 19 Db DIL in the 3<sup>rd</sup> octave band, density of on pound per square foot.

- B. Material shall be rated for use in plenums.
- C. Basis of design: Peabody Noise Control, Kinetics MDL # KNM 100B.

## **2.5 FLEXIBLE FOAM PLASTIC**

- A. Thermal Conductivity: 0.27.
- B. Water Vapor Transmission: 0.08.
- C. Flame-spread rating of 25 or less and a smoke-developed rating of 50 or less as tested by ASTM E 84.
- D. Manufacturer: Armaflex, Aerotube, Rubatex.

## **2.6 FIXTURE INSULATION ASSEMBLY**

- A. Protective, molded, fire-resistant foam insulation, single piece insulation manufactured specifically for plumbing fixture supplies and drains.
- B. 4.5 lbs per cubic foot foam with insulation R factor 2, white fire retardant polyurethane integral skin, twist fasteners.
- C. Truebro Lav Guard 2, TCI Products, or approved equal.

## **2.7 CANVAS JACKETING**

- A. Insulating Lagging Canvas: Eight ounces per square yard minimum, fire-retardant material complying with fire ratings specified above. Manufacturer: Chas Harmon "Osnaberg," Claremont Company Inc., "Claretex," or approved equal.
- B. Lagging Adhesive: Plastic synthetic resin emulsion adhesive; watertight, mildew resistant, fire retardant. Manufacturer: Miracle LA69, Borden Aeorbol, Childers Chil-Perm CP or approved equal.

## **2.8 METAL JACKETING**

- A. 27 gauge (U.S. Standard) heavy corrugated aluminum.
- B. Preformed fitting covers.

## **2.9 COATINGS**

- A. Coatings: UL labeled.
- B. Provide vapor barrier type coatings on cold service lines.

## **2.10 PREFORMED FITTING COVERS**

- A. One piece premolded PVC jacketing and fitting covers specifically designed for the service intended.
- B. Install per manufacturer's instructions and secure with manufacturer's color matching PVC tape.
- C. Manufacturer: J-M "Zeston" TeeCee, Proto, Certainteed.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Do not apply insulation materials until surfaces to be covered are clean and dry and foreign material such as rust, dirt, etc. is removed.
- B. Keep insulation clean and dry during installation and during the application of any finish.
- C. Do not install insulation on service piping systems until systems are tested and approved.

- D. Do not install insulation on ductwork until the ductwork has been tested and approved.
- E. Do not apply under conditions of excessive humidity or at temperatures below 50 degrees F. or above 100 degrees F.

**3.2 PIPE INSULATION**

- A. Protect insulation against damage. Provide metal jacketing for all calcium silicate insulation applied to piping subject to foot traffic. (i.e. low mounted horizontal piping in mechanical rooms.) Lag all other exposed insulation with heavy canvas lagging.
- B. Design insulation system for easy access at expansion joints, valves, test plugs, sensors and meters. Consider removable/replaceable insulation blocks or blankets.
- C. Insulate rain leader piping for the entire length of the run inside building to prevent condensation.
- D. Insulate VTR from top to a point 4 feet inside building vapor barrier. Flash and weather seal as appropriate for specified roof construction.
- E. Pipe hangers: Outside insulation on chilled water and recirculated cold water piping. All other locations directly against pipes.
- F. Extend test plugs, sensors, valve stems, and other devices mounted on insulated pipes above insulation on stand-offs and stems. ‘Dishing’ the insulation and vapor retarder jacket not permitted.
- G. Cold Piping:
  - 1. Includes rainwater piping, domestic cold water, plumbing and other vents through roof, chilled water and other cold piping to zero degrees F.
    - a. Insulate aboveground rain leaders from the roof drain to the point pipe penetrates building skin or below grade. Cover underside of roof drain.
    - b. Insulate plumbing vents from three feet below the under deck of the roof to the termination above the roofline.
  - 2. Insulate with sectional fiberglass and provide a completely sealed vapor barrier. Provide insulation thickness per Insulation Thickness Table.
  - 3. Insulate valves, fittings, tanks and air separators, except where indicated.
- H. Hot Piping:
  - 1. Includes domestic hot water supply and recirculation, and hydronic heating.
  - 2. Insulate with sectional fiberglass. Provide insulation thickness per Insulation Thickness Table.
  - 3. Do not insulate valves, unions, flanges and similar components unless indicated.
- I. Humidifier Steam Piping: Insulate from humidifier to air handler casing with 2” fiberglass.
- J. Buried Piping
  - 1. Insulate with flexible foam plastic insulation; glue seams with manufacturers recommended cement.

Insulation Thickness Table (units are in inches)

Fluid Design Operating Temperature Range	Run outs up to 2”	3/4" to 1-1/2"	2" to 2-1/2"	3 to 6	8" and up
Heating Systems (Water and Glycol Solutions):					
141 degrees F. to 200 degrees F.	1.0	1.0	2.0	2.0	2.0
Domestic (Hot Water and Hot Water Circulation):					

Fluid Design Operating Temperature Range	Run outs up to 2"	3/4" to 1-1/2"	2" to 2-1/2"	3 to 6	8" and up
105 degrees F to 140 degrees F	1.0	1.0	1.5	1.5	2.0
Cooling Systems (Chilled water and Glycol Solutions):					
40 degrees F to 55 degrees F	1.0	1.0	1.5	1.5	1.5
Below 40 degrees F	1.0	1.0	1.5	1.5	1.5
Domestic Cold Water::					
All	1.0	1.0	1.0	1.5	1.5
Rain leaders, Plumbing vents through roof:					
All	1.0	1.0	1.5	1.5	1.5

\*Run out piping not exceeding 4 feet or 1 inch diameter need not be insulated.

- K. In addition to specified jackets, provide heavy corrugated aluminum jacket on piping insulation anywhere piping is exposed below eight feet zero inches above floor in public areas or subject to crush damage during maintenance in mechanical spaces (i.e. using piping as a "step").

### 3.3 TECHNIQUE FOR APPLICATION TO PIPES

- A. Close longitudinal joints of pipe insulation firmly and butt insulation sections firmly together. Neatly and smoothly adhere laps and butt strips.
- B. Clean the contact area on jacket for adhesive lap strips and butt strips so it is free from fingerprints, oil, construction dust and other contaminants. Clean surfaces with tack rags, methanol, or other suitable agent before attempting to adhere the strip. Apply pressure to adhesive strip with suitable tool immediately after adhering. Remove insulation with inadequately sealed joints and install new sections. Outwardly clinching staples may be used to reinforce joints.
- C. Continuously seal vapor barriers. If staples are used at laps, seal the entire length of stapled lap with adhesive jacket tape applied as specified above for laps and butts. Sectionalize vapor barrier by sealing ends of insulation sections at not more than 25 feet intervals, to prevent moisture migrating lengthwise. Apply butt strips over joint as above.
- D. Provide double insulation thickness on piping in outside walls and within five feet of vehicle doors or other large openings.
- E. Except as indicated, locate pipe hangers and rollers outside insulation. Provide insulation saddles or sheet metal shields, around insulation. On pipes two inches and larger, within the area of each insulation shield, use calcium silicate or cellular glass on the lower half of the insulation, equal in thickness to adjacent insulation.
- F. Where piping is installed outdoors, provide two-layer glass cloth and four-layer weatherproof vapor barrier adhesive coating, in addition to jacket specified.

### 3.4 TECHNIQUE FOR APPLICATION TO PIPE FITTINGS, EQUIPMENT AND VALVES

- A. Insulate fittings, valves and flanges to the same thickness as the pipe insulation.
- B. Any of the following methods of insulation is acceptable:

1. Blanket Wrap: Wrap the fitting with compressed glass fiber blanket. Wire the blanket securely in place, then cover with a smooth layer of insulating/finishing cement. Cover with glass mesh tape, adhering it with an adhesive coating.
  2. Fabricated Segments: Cut mitered segments from pipe insulation that has the same wall thickness as adjacent pipe insulation, to form a cover which will fit snugly around the fitting. Wire the segments firmly in place and seal the joints with insulating/finishing cement. Apply adhesive coating and wrap with glass mesh tape, then apply another layer of the same coating over the whole assembly.
  3. Cement: Apply insulating or insulating/finishing cement, molding it to the contour of the fitting. When area is large apply an under layer of cement, wrap this with glass mesh tape, then apply an outer layer of cement. If the insulation is not concealed, the exposed surface of insulating/finishing cement to have a final glass mesh tape wrap embedded in adhesive.
- C. In each of the listed methods, to protect the insulation against contact damage, apply an adhesive coating when the cement is completely dry and hard, then wrap with glass mesh tape. Apply another coating of adhesive over the whole assembly.
- D. In each of the listed methods, pre-formed fitting covers may be substituted for the tape and adhesive covering specified. Cement and tape fitting covers on cold piping to provide a positive vapor barrier.

### 3.5 DUCT THERMAL INSULATION REQUIREMENTS

- A. Insulate ductwork as follows:
1. Plenums:
    - a. Insulate and vapor barrier outside air intake ducts/plenums from air intake point to equipment connections with two-inch (2") fiberglass insulation.
    - b. Insulate and vapor barrier exhaust fan and relief fan plenums with two inches (2") fiberglass insulation.
    - c. Do not attach conduit, J-boxes, control devices or other equipment directly to insulated plenums. When attachment is required, provide stand-off brackets with thermal isolation so as not to compromise the plenum insulation or vapor barrier.
  2. Ductwork:
    - a. Insulate supply ductwork for mechanically cooled systems with 1-1/2 inch fiberglass insulation.
    - b. Insulate return and transfer ductwork passing through unheated spaces with 2 inch fiberglass insulation.
- B. Insulation Type and Finish:
1. Rigid or semi-rigid board where canvas or metal jacket is specified. May also be used in place of blanket insulation where practical.
  2. Blanket insulation where rigid board is not specified or indicated. Proper installation is critical. Loose joints and sagging insulation shall require re-insulation of entire branch or main duct before acceptance and during warranty period.
  3. Heavy canvas jacket over board insulation in mechanical rooms and opened ceiling public areas.
  4. Ductwork insulation shall have a completely sealed vapor barrier.

### 3.6 DUCT SOUND INSULATION REQUIREMENTS

- A. Install duct sound lining as indicated.
- B. Install sound lining in accordance with manufacturer's installation instructions. Completed installation shall be fastened tightly to ductwork and free of sags.
- C. Provide metal noising at both upstream and downstream termination points regardless of duct velocity.

### 3.7 TECHNIQUE FOR APPLICATION TO DUCTWORK

- A. Rigid and Semi-rigid Insulation:
1. Impaling Over Pins: Install insulation with edges tightly butted using adhesive and metal pins. Impale insulation on pins welded to the duct and secure with speed clips. Trim off pins close to speed clip. Space pins as required to hold insulation firmly against duct surface but not less than one pin per square foot.
  2. Other Method of Securement: If the welded pin method is impossible, secure the insulation to the duct with adhesive. Cover the entire surface of the metal with adhesive when applying to the underside of horizontal ducts. Application to top and sides may be in strips with a minimum of 50 percent coverage. Additionally, secure insulation with No. 16 galvanized wire on not more than 12 inches on center. Provide metal angle at corners to protect edges of insulation.
  3. Vapor Barrier: Seal joints and speed clips with adhesive tape of similar construction to insulation jacket. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique. Glass cloth tape set in adhesive may be used. Provide metal or plastic corner angles within eight feet of floor, walkway, or stairs.
  4. Provide canvas jacket where specified. Completely cover with 8 30-36 lagging adhesive. Size canvas with two heavy coats of same adhesive and completely fill the weave. Inspect when dry for complete vapor barrier throughout and refinish as required.
- B. Blanket Insulation:
1. Position insulation so that longitudinal seam will be underneath and not supporting weight of sheet. Remove a uniform strip of insulation from backing to provide a lap strip. Butt insulation and secure lap strip with outwardly clinching staples.
  2. Use pins to secure blanket on large flat areas as specified for rigid insulation. Reinforce jacket at pin penetration where required.
  3. Seal laps, staples and butt joints with adhesive tape of similar construction to insulation jacket. Seal speed clips if used. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique.
  4. When system is under pressure, inspect insulation for inflation caused by improperly sealed ducts. Repair duct seal and re-insulate as necessary.
  5. The Department's Representative may inspect completed insulation and test taped joints for adhesion. Seal laps and butt tapes that can be removed with reasonable force shall require that entire branch or trunk duct be reinsulated.

### 3.8 FIXTURE INSULATION ASSEMBLY

- A. Insulate hot water supply and waste piping exposed beneath sink and lavatory fixtures designated on drawings or specified in Section 22 40 00 Plumbing Fixtures as intended for use by the handicapped. Install in accordance with ANSI A117.1.

### 3.9 LIMP MASS SOUND INSULATION

- A. Install in accordance with the manufacturers' instructions.

### 3.10 PAINTING

- A. Paint exposed insulation in utility areas, service areas, mechanical rooms and opened ceiling public areas in accordance with Section 09 90 00 – Painting.
- B. Color selected by the Department's Representative.

**END OF SECTION 20 07 00**

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**SECTION 22 11 00**  
**FIRE PROTECTION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes: Specific performance requirements, products, and methods of execution relating to fire protection for the project. This is substantially a performance specification.
- B. Related Divisions and Sections:
  - 1. Division 1
  - 2. Division 9
  - 3. Divisions 26, 27, and 28
  - 4. Divisions 20, 22, 23 and 25
  - 5. Section 01 91 00 Commissioning
  - 6. Section 28 31 13 - Addressable Fire Alarm System

**1.2 REFERENCES**

- A. Provide fire protection in accordance with the minimum provisions of the following codes and standards:
  - 1. International Fire Code - 2009, IFC.
  - 2. International Building Code - 2009, IBC.
  - 3. Uniform Plumbing Code – 2009, UPC.
  - 4. NFPA 13 - 2010, Installation of Sprinkler Systems.
  - 5. NFPA 24 - 2010, Installation of Private Fire Service Mains and Their Appurtenances.
  - 6. NFPA 25 - 2011, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
  - 7. NFPA 33 - 2011, Spray Application Using Flammable or Combustible Materials.
  - 8. NFPA 40 - 2011, Storage and Handling of Cellulose Nitrate Film.
  - 9. NFPA 101 - 2009, Life Safety Code.
  - 10. NFPA 232 - 2012, Standard for the Protection of Records.
  - 11. NFPA 291 - 2010, Fire Flow Testing and Marking of Hydrants.
  - 12. NFPA 909 - 2010, Code for the Protection of Cultural Resource Properties – Museums, Libraries, and Places of Worship.
  - 13. ASCE 7 - 05, Minimum Design Loads for Buildings and Other Structures.
  - 14. Foundation for Cross-Connection Control and Hydraulic Research, 9th edition, University of Southern California.
  - 15. Underwriters Laboratories, UL, Fire Protection Equipment Directory.

**1.3 SYSTEM DESCRIPTION**

- A. Provide complete wet and dry pipe automatic fire sprinkler systems hydraulically calculated to protect the entire facility, complete in every detail, and fully operational. Comply with the Contract Documents requirements, applicable codes and standards, as well as the Authority Having Jurisdiction requirements. Provide sprinklers throughout the building, including outside roof canopies, paint spray booth, freezers, coolers, cellulose nitrate film storage, file storage areas, loading dock, parking garage, wood and metal shops, wood crate storage, built-in display cabinets, library reading and stack areas, exhibit areas, mezzanines, mechanical areas, balconies, mobile shelving systems, and all building areas as shown and described in the contract documents.
- B. Coordinate work with phasing requirements to allow the phase 2A areas to be fully occupied and operational with minimal impact during phase 2B construction including acceptance and commissioning activities.

- C. Work includes complete installation of piping and sprinklers in many types of spaces and finished ceilings, architectural features, and building lines. Route piping above ceilings where possible; exposed pipes shall follow architectural elements/building lines for visual appearance. Design and installation of sprinkler systems shall incorporate review aesthetic comments including routing of lines, exposed pipe, sprinkler head finish and locations.
- D. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per NFPA 13, International Building Code, and ASCE 7; most conservative criteria shall govern.
- E. Provide listed sprinkler flex hose for sprinkler heads in ceiling assemblies; other methods to maintain required clearances are not allowed.
- F. Provide provisions for inspection, testing, and maintenance of water-based fire protection systems identified in NFPA 13 and NFPA 25.
- G. Provide labor, materials, and equipment as required to facilitate the commissioning process of systems and equipment within this scope of work. Perform tests and verification procedures required for the commissioning process as requested by the Contracting Agency and directed by the Contractor's Commissioning Representative.
- H. Sprinkler systems shall follow these general requirements:
  - 1. All areas and spaces shall be protected by the automatic sprinkler systems.
  - 2. Garage and related areas shall be dry pipe system with all sprinkler piping concealed in areas with ceiling soffit or other finished areas.
  - 3. Loading dock and similar exterior areas shall be dry pipe system.
  - 4. Phase 2A level 1 and 2 secure collections and secure storage areas and adjacent areas including; low temperature storage, isolation, and processing shall be Ordinary Hazard 2 as a minimum; areas being generally describe as level 1 between grids A-H and 1-4, level 2 between grids A-H and 1-4.
  - 5. Automatic fire protection for paint spray booth and exhaust duct system.
  - 6. Controlled access mechanical areas without fired equipment shall be Light Hazard.
  - 7. NFPA 13-2010 Ch. 5 Classification of Occupancies and Commodities, Ch. 11.2.3 Water Demand Requirements, and Ch. 21 Special Occupancy Requirements shall be the minimum criteria for automatic fire protection.

#### 1.4 SUBMITTALS

- A. Submittals shall be complete for review. Drawings, calculations, and product cutsheets shall be complete and submitted together in one package. Provide an electronic copy of each submittal in PDF format with bookmarks matching table of contents, including shop drawings with each required hard copy.
- B. Product Data:
  - 1. Submit product data for items specified in Part 2 and those products required by the performance standards of this Section. Identify catalog designation and/or model number and neatly annotate each salient characteristic and design option of the product. Identify operation characteristics, performance curves and rated capacities of products and devices to show compliance with shop drawings and calculations.
  - 2. Provide exterior and interior signage with indicated placement locations.
  - 3. Provide data on firestopped penetrations, including product being submitted, the rating of the assembly it will be used for, and the applicable Through Penetration Firestop System drawing(s) from the UL Fire Resistance Directory.
- C. Shop Drawings:
  - 1. Shop drawings shall be prepared using the latest release of AutoCAD.
  - 2. Submit Fire Marshal approved sets of shop drawings and calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature, or signed seal of a licensed professional engineer, and the fire protection Contractor's Alaska specialty license number.

3. Shop drawings, hard copies and PDF files, shall be submitted with information in compliance with NFPA 13 and other performance standards of this Section. Shop drawings shall include but not limited to the following:
  - a. Name of Contracting Agency, Occupant and Building Permit number.
  - b. Location, including street address and legal description.
  - c. Point of compass.
  - d. Fire Department connections.
  - e. Necessary controlling equipment.
  - f. Location of water source, type, routing, depth of bury, and size of supply piping. Identify location and size of city main and whether it is dead-end or circulating loop and distance to the flow data test hydrant.
  - g. Distribution system piping and outlets. Include pipe and fitting types.
  - h. Sprinkler connection, drop, details including supports required for flex pipe.
  - i. Supports, brackets, restraints, and seismic attachments details and schedules.
  - j. Reflected ceiling plan showing ceiling heights, construction type, proposed location and type of sprinkler heads, and other ceiling devices such as HVAC diffusers, loud speakers, type and location of light fixtures, etc.
  - k. Interference control between sprinkler system and other trades.
  - l. Full height cross section, indicating basic building construction system, sprinkler piping arrangement, and elevation of the highest sprinkler head.
  - m. Location of partitions. Identification of full height walls and draft stops.
  - n. Location and size of unprotected concealed spaces.
  - o. Identification of unheated areas and areas that cannot be reliably maintained above 40 deg. F.
  - p. Water flow test results, include testing agency, time, date, and location of test.
  - q. Make, model, type, orifice, finish, color, and temperature rating of sprinklers and their respective locations.
  - r. Sprinklers with sprinkler guards.
  - s. Clearly identify each hydraulic remote area and associated calculations.
  - t. Hydraulic node points.
  - u. The square footage area protected by each system.
  - v. Make, model, and size of all valves and equipment including: control valves, alarm valves, check valves, hose valves, and related appurtenances.
  - w. Identify drum drip drains, main drain, low point drains, drain receptors, and inspector test stations.
  - x. Indicate the type and location of piping hangers, equipment supports, seismic movement, and seismic restraints.
  - y. Make, model, size, and locations of pipe couplings, fittings, and flanges.
  - z. Make, model, size, power requirement, and location of alarm bells, buzzers, detectors, switches, air compressors, and panels.
  - aa. Provisions for flushing and backflow device system demand forward flow test and test discharge to safe location.
  - bb. Name, address, and telephone number of the Contractor. If design is by a separate firm, include the name address, telephone number, and fax number of the design facility.
  - cc. Complete legend of abbreviations and symbols indicated.
  - dd. Complete schedule of room occupancies and associated NFPA occupancy hazard.
  - ee. Location of structural penetrations and verification that all structural penetrations have been coordinated and approved.
  - ff. Note the size, location, and extent of "exposed" piping.
  - gg. Location of fire rated assemblies.
  - hh. Total number of sprinklers on each dry-pipe system.
  - ii. Capacity in gallons of each dry-pipe system.

D. Design Data:

1. Submit Fire Marshal approved sets of calculations. Drawings and calculations shall include the NICET certification and State of Alaska Permit IIC or IIC-DO number and signature or stamp of a licensed professional engineer and the fire protection Contractor's Alaska specialty license number. Submit complete hydraulic calculations which were used to prepare the final design drawings. One set will be retained by the Engineer.
2. Systems shall be limited to a maximum of 175 psig, unless otherwise approved. Systems requiring pressures 175 psig and higher shall have pressure reducing valves, controls, and related equipment incorporated.
3. Product data, shop drawings, and calculations shall be submitted together for review. Partial submittals will not be reviewed.
4. Submit water flow information used for all hydraulic calculations:
  - a. Fire hydrant flow tests shall be in accordance with NFPA 291 and the Authority Having Jurisdiction and submitted for approval to the AHJ.
  - b. The Contractor shall submit a written procedure and certification for the test, which shall be in compliance with NFPA 13 and NFPA 291 for flow testing water supplies. Provide a minimum of 48 hours advance notice of test to the Contracting Agency.
  - c. Hydraulic calculations shall be accomplished in compliance with the procedures established in NFPA 13. In addition to minimum NFPA 13 standard, a minimum 10 percent pressure and flow buffers are required to be designed into the system. Where local authorities require additional buffer, the Contractor shall comply with the more demanding requirement.
  - d. Hydraulic calculations accomplished by computer program for submittal shall be accompanied by a complete legend of the abbreviations, nodes, and symbols utilized on the computer readout.
  - e. Hydraulic calculations shall clearly identify the following:
    - 1). System type, sprinkler "K" factor, and "C" factor.
    - 2). Pipe and fittings type.
    - 3). Fitting equivalent length chart that complies with the "C" factor and pipe type.
    - 4). NFPA hazard designation, design density, and size of the design remote area.
    - 5). The elevation of the "highest" sprinkler.
    - 6). The available water supply and system demand at the point of connection to the water supply, indicated on a logarithmic graph. Include hose demands.

E. Quality Assurance/Control Submittals:

1. Design Data. Provide hydrant flow test reports or other information used for design.
2. Certificates:
  - a. Submit Contractor's qualifications, proof of three years experience under this Contractor's firm name, and references for at least five projects in Alaska of similar type, size, or complexity.
  - b. Submit a copy of designer's NICET certification and resume', Alaska Permit number and level or Alaska P.E. license number.
  - c. Submit a copy of backflow assembly tester qualifications and certificate.
  - d. Submit a letter of certification for the installation, signed by the backflow assembly installer/tester.
  - e. Submit a copy of Contractor's State of Alaska Fire Protection Permit and Administrator's License for the appropriate type of systems provided.
  - f. Provide certificates for above ground and below ground tests required by applicable codes and standards.
  - g. Provide a letter of certification stating that testing and flushing has been performed in accordance with the applicable codes and standards. Itemize codes and standards complied with.
  - h. Provide copy completed of the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Above Ground Piping.

3. Provide Manufacturer's Installation Instructions, and Manufacturer's field reports.
  4. Fire protection system shall be installed, tested, as-builts completed and installation approved by the Authority Having Jurisdiction, AHJ, before substantial completion request or notification shall be made.
  5. Structural tests and special inspections required by IBC or ASCE-7 shall be identified on the shop drawings, products submitted and coordinated during installation; reports shall be submitted. Contractor shall secure required services and pay for tests and inspections.
  6. Significant changes in piping due to on site coordination with other trades and existing conditions shall require hydraulic recalculation to confirm adequate pipe sizing and be resubmitted to AHJ and Contracting Agency's Insurance agency.
- F. Review, Approvals, and Permits Required:
1. Obtain written review and/or approval of the entire fire protection system design and arrangement from the following authorities:
    - a. Contracting Agency - (Approval).
    - b. Authority Having Jurisdiction, AHJ - (Approval).
    - c. Architect - (Review).
    - d. Mechanical Engineer - (Review).
  2. Comply with the above review comments, revising the system design as required, and resubmitting in a timely manner, so as not to hinder the construction schedule.
  3. Obtain and pay for required permits, inspections, tests, and approvals as required by Authority Having Jurisdiction.
  4. Design and installation of sprinkler systems shall incorporate changes to compliment building usage and architectural features including routing of pipes, sprinkler layout and styles, and attachments to pipes.
- G. Operation and Maintenance Manual Submittal:
1. Include manufacturers' descriptive literature, operating instructions, installation instructions, testing certificates, maintenance and repair data, parts listings, and spare parts list.
  2. Electronic copy of the Authority Having Jurisdiction approved hydraulic calculations, drawings, and their review letter.
  3. Table showing NFPA 25 maintenance requirements.
  4. Provide an electronic copy of operations and maintenance manual in PDF format with bookmarks matching table of contents, including as-built shop drawings with each required hard copy.
- H. Closeout Submittals:
1. Refer to Division 1 for general procedures for submittals.
  2. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
  3. Warranty: Submit manufacturer warranty and ensure forms have been completed in Contracting Agency's name and registered with the manufacturer.
  4. The Contractor shall submit a written affidavit at the completion of the system, stating that the fire protection system as installed complies with referenced Codes and Standards, Authority Having Jurisdiction requirements.
  5. Provide written warranty as specified in Division 1.
  6. The Contractor shall issue minimum one set of full size as-built drawings and maintenance data to the Contracting Agency's designated maintenance personnel, in addition to required submittals.
  7. Contractor shall fully train the Contracting Agency's designated maintenance personnel in the operation and maintenance of the entire fire protection system. Minimum four hours of training required.
- I. Maintenance Information and Framed Building Plan:
1. Provide information for a complete building floor plan showing system control valves, drain stations, alarm and control panels, test valves, fire pumps and controllers, water

- storage tank(s) and other primary fire protection devices. Indicate sprinkler zones, boundaries, and types of systems. Submit this plan prior to substantial completion for review by the Contracting Agency. Coordinate with fire alarm control panel and graphics for nomenclature, devices, sprinkler zones, and other common elements.
2. Enclose the plan in a professionally fabricated metal picture frame with 1/8 inch rigid clear plastic cover. Minimum 1 inch frame width. Locate the framed plan in the fire protection control valve room on the wall with the spare sprinkler cabinet.
  3. Include step by step instructions to place the fire protection system in service as well as to take it out of service. Provide complete maintenance information of primary fire protection equipment, valves, fittings, sprinklers. Identify equipment indicating whether devices are replacement items or repairable. Provide parts list and suppliers for repairable items.
  4. Provide three copies of the latest edition of NFPA 25.
  5. Include step by step procedures for required operational weekly/monthly/annual service and testing as required by NFPA 25. Provide a complete report of field test operations and results prior to substantial completion.
- J. Record Drawings:
1. Maintain current and up-to-date As-Built prints of the fire protection system at the job site, in accordance with Division 1.
  2. Approved full size As-Built drawings and electronic copy of as-built drawing files in PDF and AutoCADdwg formats shall be submitted with IO&M manuals.

## 1.5 QUALITY ASSURANCE

- A. Furnish the services of a qualified and approved fire protection subcontractor to provide the work of this specification section. Unless otherwise noted, this is substantially a "performance" specification.
- B. Minimum qualifications of the Contractor/subcontractor shall include the following:
  1. Specialist Firm: Company specializing in automatic fire protection/sprinkler systems, possessing a minimum of three years experience with systems similar in nature to the type specified herein. Demonstrate satisfactory completion of five projects of similar size and scope in the State of Alaska. Provide references.
  2. Backflow Prevention: Installation and testing by a certified backflow assembly tester, in accordance with the Uniform Plumbing Code and Foundation for Cross-Connection Control and Hydraulic Research. Provide a copy of the certification and test results.
  3. Design Certification: Drawings and calculations shall be prepared by a Level III or IV Fire Sprinkler Designer, certified by the National Institute for Certification in Engineering Technologies (NICET), in Fire Protection Engineering Technology Automatic Fire Sprinkler System Layout who also have their State of Alaska Permit IIC or IIC-DO license, or an Alaskan Licensed Professional Engineer.
  4. Maintain a complete stock of replacement parts.
  5. Remain on 24 hour call for emergency service.
  6. Maintain an office and telephone, with authorized representatives of the Fire Protection Contractor's firm, including the Designated Project Administrator, with a physical presence and address in Alaska.
  7. Bids by wholesalers, contractors, or any firm whose principal business is not that of manufacturing and/or installing fire protection systems are not acceptable.
- C. Material: Equipment and components: Bear the "UL" label or the "FM" approval marking.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to the site under provisions of Division 1.
- B. Deliver and store valves in manufacturer's packaging with labeling in place.
- C. Prior to installation, piping shall be wrapped with protective wrapping.

## **1.7 PROJECT/SITE CONDITIONS**

- A. Temporary occupancy permits, or partial occupancy require alarm and life safety systems to be fully operational. Expedite installation and complete life safety requirements for temporary occupancy. Existing portions of the building will be occupied and fully functional during Phase 2B construction.
- B. Work shall be scheduled to minimize disruption of automatic fire protection service, coordinate with Owner for shut down and maintain a fire watch when the existing system is inoperable.
- C. Check dimensions indicated on the Architectural or Structural Drawings, and verify dimensions at the site before fabricating any portion of the system. Any discrepancies in piping and head locations resulting from failure to do so shall be corrected expeditiously to provide proper coordination of trades.
- D. Coordinate work with that of other trades to make sure that adequate space is provided, including requirements for accessibility and serviceability. Locate sprinkler heads a minimum 6 inches distance from ceiling T-Bar, structural elements, devices, and other installed equipment. Adjust final location of piping and heads in field to accomplish these requirements for coordination.
- E. Identify structural penetrations for piping, and submit details of those penetrations to the Structural Engineer for approval. Replace structural members that are damaged, cut, or penetrated without approval at no additional expense to the Contracting Agency. Provide pipe a minimum of 1-inch clearance from all structural elements.
- F. Contractor shall review the contract documents and any Owner furnished equipment and determine if any portion of the existing fire protection system will be affected by the temporary or permanent implementation of any portion of this work. Contractor shall provide Owner and Engineer a list of the specific fire protection and detection systems affected before proceeding with design or demolition.
- G. Design automatic fire protection piping in this facility with full consideration given to the building occupants, minimizing inherent health risks caused by self inflicted injury from the fire protection system and/or damage to the system. This includes but is not limited to exposed piping, security of system controls and service points, and sprinkler types specified for this application.

## **1.8 ANNUAL MAINTENANCE AGREEMENT PROPOSAL**

- A. Provide upon request a cost proposal for performing annual maintenance.
- B. For sprinkler systems, include the cost of performing maintenance recommended by NFPA 25.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Provide only products that are a standard product of a manufacturer regularly engaged in the manufacture of fire protection equipment.
- B. Submittals are required for all equipment, materials, and products.
- C. Glycol systems for fire protection shall not be used.

### **2.2 LABELS, TAGS, AND APPROVALS FOR PRODUCTS**

- A. Products UL or FM listed, labeled, and specifically approved for the fire protection application where they are used.
- B. Label pipes, riser assemblies, pre-action systems, and alarm valves, including zone designation.
- C. Tag equipment for maintenance and operations; include in shop drawings and IO&M manual.

## 2.3 MANUFACTURERS

- A. Sprinkler System Components:
  - 1. Reliable.
  - 2. Grinnell
  - 3. Gem Sprinkler
  - 4. Central.
  - 5. Star.
  - 6. Viking.
  - 7. Kennedy.
  - 8. Milwaukee.
  - 9. Potter-Roemer.
  - 10. Victaulic.
  - 11. Potter Electric.
  - 12. Tyco.
  - 13. Tolco.
- B. Submittals are required for all equipment, materials, and products.

## 2.4 PIPE AND FITTINGS

- A. The use of pipe nipples less than 1-inch in diameter shall not be allowed.
- B. Wet Pipe Sprinkler Systems:
  - 1. All piping shall be listed for the intended service by UL or FM.
  - 2. Whenever piping other than steel schedule 40 is utilized, submit a statement that the piping complies with NFPA 13 standards, the piping strength is adequate for the application, and the piping corrosion resistance ratio (CRR) shall be equal or greater than 1.0, equivalent to schedule 40 pipe. Include this CRR data in product submittal.
- C. Dry Pipe Sprinkler Systems:
  - 1. Schedule 40 hot dipped galvanized steel piping in accordance with NFPA 13. Welded fittings shall not be used on galvanized pipe. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.
  - 2. Valves shall be bronze.

## 2.5 FLEXIBLE SPRINKLER HOSE WITH THREADED END FITTINGS

- A. Flexible one-inch stainless steel flexible sprinkler hose products shall be FM Global or UL tested and approved and submitted for the specific application.
- B. Equivalent length of 1" schedule 40 steel pipe and pressure drop information shall be included in product submittal and hydraulic calculations.
- C. All sprinkler heads shall be connected to system via minimum 1" diameter flexible sprinkler hose in suspended ceiling areas, areas subject to tenant renovations, where indicated, and where required for seismic criteria.

## 2.6 FITTINGS

- A. Grooved Fittings, Couplings, and Mechanical Tees:
  - 1. Grooved Fittings: Victaulic, Gruvlok, Sprink, cast iron, ductile iron or equal. Fabricated or segmented fittings are not acceptable. Couplings and mechanical tees shall be standard painted Victaulic, Gruvlok, or equal.
  - 2. Slip-Fit fittings and couplings utilized for joining branch piping to new main piping shall be "Victaulic" or "Gruvlok" brand as required.
- B. Threaded Pipe Fittings: Cast iron 125 pound ANSI B16.4 or ductile iron 300 pound ANSI B16.3.
- C. Pipe Flanges: Cast Iron Class 125 pound ANSI B16.5.

- D. Welded Pipe Fittings for Wet Pipe Sprinkler Only: Limited to Weld-o-lets, Thread-o-lets, Gruv-0-lets and Welded Flanges.
- E. Welded fittings shall not be used on galvanized pipe and on pipes equal to or less than schedule 10.
- F. Other means of joining pipe are not permitted.

## 2.7 VALVES AND ALARM ASSEMBLIES

- A. Valves: UL or FM listed and labeled and specifically approved for the fire protection application where they are used. Minimum working pressure 175 psi non-shock cold water. Higher pressure rating as required.
  - 1. Control Valves: Fire protection system control valves shall be supervised with switches compatible with the fire alarm system or other methods in full compliance with NFPA 13.
    - a. OS&Y Gate Valves: Minimum working pressure 175 psi non-shock cold water. UL listed for fire protection.
    - b. Provide supervision of each fire protection control valve, compatible with fire alarm system.
    - c. Butterfly Valves: UL listed for fire protection 175-psi non-shock cold water, with integrated supervisory switch. Grooved, threaded, or wafer type acceptable.
    - d. NRS Gate Valves: Minimum working pressure 175-psi non-shock cold water. UL listed for fire protection.
  - 2. Swing Check Valves: UL listed for fire protection 175-psi non-shock flanged, or wafer type acceptable.
  - 3. Backflow Device: Backflow assemblies and devices shall have successfully passed the laboratory and field evaluation tests conducted by the University of Southern California Foundation for Cross-Connection Control and provided in accordance with the Uniform Plumbing Code requirements.
  - 4. Test and Drain Valves:
    - a. Test orifices shall be clearly identified and selected for smallest sprinkler orifice on system riser.
    - b. Drain valve, minimum 2-inch.
    - c. Sight glass for visual confirmation of water flow.
    - d. Valve assembly shall be bronze body.
  - 5. Drain valves: Threaded bonnet type bronze glove valves.
  - 6. Provide sprinkler alarm valve assemblies, appropriate to the system, complete with trimmings and accessories for proper alarm initiation and interface with fire alarm system. Include inlet and discharge pressure gauges, main drain, and inspectors test connection.

## 2.8 WET PIPE AUTOMATIC SPRINKLER SYSTEMS.

- 1. Alarm Check Valve Assemblies.
  - a. Provide sprinkler alarm valve assemblies, appropriate to the system, complete with trimmings and accessories for proper alarm initiation and interface with fire alarm system .
  - b. Include inlet and outlet pressure gauges, and main drain with safe discharge to the outside.
- 2. Water Flow Detectors.
  - a. Provide water flow detectors installed at each system or zone control and for the main system header for multiple zone systems.
- B. Dry Pipe Sprinkler Systems.
  - 1. Dry Pipe Valve.
    - a. Dry Pipe Valve, complete with required trimmings, including inlet and outlet pressure gauges and main drain that safely discharges outside.
    - b. Pressure Switch, to signal system discharge.

- c. Low Air Alarm Switch, to signal low air pressure in the dry-pipe fire-protection system.
- d. Accelerator - As required with trim, compatible with the dry pipe valve.
- C. Provide electrical alarm and control wiring in accordance with Divisions 26, 28, and NFPA 72.
- D. Provide identification sign (enamel on metal) for valves per NFPA requirements.
- E. Valves in galvanized piping systems shall be bronze.

## **2.9 DRY PIPE SYSTEM AIR MAINTENANCE AND APPURTENANCES.**

- A. Air compressor of size, configuration and capacity as required by NFPA 13.
- B. Air receiver ASME stamped, pressure gauge, relief valve and automatic drain trap piped to floor for tank mounted compressors.
- C. Compressor: Single unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloading valve.
- D. Provide 115V, 1Ph motor suitable for connection to 15 amp circuit.
- E. Provide monitoring panel with low air pressure alarm switches on each system, compatible with fire alarm system.

## **2.10 SPRINKLER HEADS**

- A. Provide sprinklers as required by NFPA 13 standards and in compliance with the IBC Chapter 9 except that sprinkler heads using O-ring water seals are not allowed. Sprinkler finish and style below shall be used as design intent. Contract shall review contract documents for additional information and requirements, and coordinate with shop drawing submittal and review process.
  - 1. In areas with surface mounted light fixtures attached to finished suspended ceilings, provide standard spray pendant sprinklers, and escutcheons to position the sprinkler deflector below the light fixture. Sprinklers and escutcheons to be chrome finish.
  - 2. In areas with recessed lighting flush to the suspended ceiling finish, provide recessed standard spray pendant sprinklers. Sprinklers and escutcheons to be chrome finish.
  - 3. Sprinklers above ceilings and exposed ceiling areas shall be bronze finish, standard spray, upright or pendant type.
  - 4. Sidewall sprinklers shall be bronze finish in service areas, and chrome throughout public areas.
  - 5. Sprinklers in main foyer, lobbies, and similar areas to be concealed type with cover finish to match ceiling finish.
  - 6. Dry pendant and sidewall sprinklers protecting inside freezers/coolers or outside overhangs shall be bronze finish, where not protected by a dry pipe system.
  - 7. Dry pendant and sidewall sprinklers protecting entry vestibules and other public areas susceptible to freezing temperatures shall be chrome finish recessed, where not protected by a dry pipe system.
  - 8. Dry pendant and sidewall sprinklers protecting unheated areas and piped from wet pipe systems shall have an "A Length" dimension of not less than 18 inches.
  - 9. Guards are required on exposed piping sprinklers throughout shipping and receiving, workshop, metal workshop, crate storage and similar rooms, and sprinklers less than seven feet six inches above finish floor. Provide the same brand sprinkler guard, with the same finish as the sprinkler on which it is to be installed. Red guards are acceptable for bronze sprinklers only. Chrome finish guards are required for chrome sprinkler heads. Physically wire guards closed.
  - 10. Sprinklers of correct temperature rating shall be installed according to NFPA 13.
  - 11. Provide required number of spare sprinkler heads of each type and temperature rating per NFPA 13 and a minimum of one sprinkler wrench for each type of installed sprinkler. Spare sprinkler cabinet shall be red sheet steel manufactured by the sprinkler manufacturer. Mount cabinet on the wall within 60 inches of the sprinkler control riser.

12. Provide additional sprinklers, as requested by Authority Having Jurisdiction, at no additional cost to the Contracting Agency.
- B. Sprinkler heads on dry pipe systems shall be listed for the application and shall be upright or pendent install on a return bend.

#### **2.11 FIRE DEPARTMENT CONNECTION**

- A. Cast brass body and trim having individual double female snoots with rigid end three inches NPT by 2-1/2 inch pin lug hose thread swivels and plugs and chains, exposed parts polished chrome finish.
- B. Provide number of snoots as required by NFPA 13.
- C. Connection to be complete with 1/2 inch automatic ball drip valve piped to exterior.
- D. Provide appropriate lettering on escutcheon plate, to properly identify connection.
- E. Provide hose threads to match the threads of the local fire department.
- F. Final location to be approved by the Authority Having Jurisdiction.
- G. Manufacturer: Potter Roemer or equal.

#### **2.12 BACKFLOW DEVICE**

- A. Provide full line size double check backflow assembly and devices in accordance with the Uniform Plumbing Code requirements before FDC or sprinkler riser connections.
- B. Backflow assemblies including approved orientations shall have successfully passed the laboratory and field evaluation tests conducted by the University of Southern California Foundation for Cross-Connection Control.
- C. Configuration of backflow device and gauges for conducting backflow device full flow test with provisions to record inlet and discharge pressures and discharge flow discharge to safe location.

#### **2.13 PIPE AND EQUIPMENT ANCHORS, BRACING, HANGERS, AND SUPPORTS**

- A. Provide seismic anchoring, bracing, supports, and clearance for equipment, piping and sprinkler heads per NFPA 13, International Building Code, and ASCE 7; most conservative criteria shall govern.
- B. Provide flexible couplings, bracing, and other components required and compatible with the piping materials and fittings.
- C. Seismic details and locations shall be included on the shop drawings.

#### **2.14 INSPECTORS TEST CONNECTIONS**

- A. Provide inspectors test connections for complete system testing and as required for final approval by Authority Having Jurisdiction.
- B. Chrome plate pipe and fittings exposed outside building; provide chrome plated set screw escutcheon.

#### **2.15 ELECTRICAL WORK**

- A. Provide all electrical components, equipment, wire, conduit, connections, and services as required by NFPA 72 and Divisions 26 and 28 requirements.

#### **2.16 ELECTRIC ALARM**

- A. Provided by Section 28 31 13 - Addressable Fire Alarm System.

### **2.17 PRESSURE GAUGES**

- A. Pressure gauges shall be 3-1/2" corrosion resistant moving parts, polycarbonate window with connection not smaller than 1/4" NPT.
- B. Include shutoff valve with provisions for draining on each pressure gauge.

### **2.18 WATER FLOW DETECTORS**

- A. Provide vane-type water flow detectors installed at each system or zone control and for the main system header for multiple zone systems.
- B. Provide water flow detectors, switches, compatible with fire alarm system.

### **2.19 VALVE TAMPER SWITCHES**

- A. Provide supervision of each manual shutoff valve compatible with the fire alarm system.
- B. Provide valve tamper switches compatible with fire alarm system.

### **2.20 DRY PIPE SYSTEM AIR MAINTENANCE**

- A. Provide simplex air compressor of size, configuration and capacity as required by NFPA 13. Provide vibration isolation mounts for air compressor equipment.
- B. Provide ASME stamped air receiver, pressure gauge, relief valve and automatic drain trap piped to floor for tank mounted compressors.

### **2.21 DRY SYSTEM LOW PRESSURE ALARM**

- A. Provide UL approved low air pressure alarm switches on each dry system, compatible with fire alarm system.

## **PART 3 - EXECUTION**

### **3.1 CONTRACTOR COORDINATION**

- A. The fire protection contractor shall coordinate his work with the work of other trades to assure timely installation and efficient use of mechanical areas including, but not limited to, boiler rooms, fan rooms, open spaces, and ceiling spaces.
- B. Promptly remove any work installed without proper coordination and reinstall in a manner to allow for a good practical arrangement of items which need to be installed by other trades involved.
- C. In case of coordination dispute, consult the Contracting Agency and its decision shall be binding.
- D. Costs associated with coordination, arranging or rearranging of the fire protection system shall be borne by the affected Contractor, without causing any additional expense or delay to the Contracting Agency.
- E. Coordinate and schedule phased construction to minimize disruption of existing fire service; coordinate with Contracting Agency for shut down and maintain a fire watch when system is inoperable.
- F. Coordinate with architectural requirements for painting of pipes, hangers, brackets, restraints, and appurtenances in public exposed areas.

### **3.2 PAINT SPRAY BOOTH**

- A. Provide sprinklers, piping, and controls for closed paint spray booth in accordance with NFPA 33-2011.
- B. Provide normally open service valve with tamper switch on branch line serving paint spray booth.

### 3.3 PIPING INSTALLATION

- A. Install piping, fittings, and appurtenances in accordance with codes and recommended practices. Follow manufacturers' installation instructions.
- B. Pipes shall be concealed, except at ceilings exposed to structure. Install piping to conserve building space and route piping around roof hatches, electrical panels, access panels, and maintenance accesses.
- C. Pipes and equipment not directly serving exit enclosures or exit passageways shall not be routed through them. Only pipes and equipment directly serving exit enclosures or exit passageways shall be allowed in these spaces. There shall be no penetrations whether protected or not between adjacent exit enclosures or exit passageways.
- D. All sprinkler pipe and fittings shall be installed such that the system can be drained. Discharge test pipes, backflow system demand flow tests, and system main drain to safe location outside. Coordinate discharge point with Contracting Agency. All piping shall be arranged to drain to the main drain valve where practicable. Where connection to the main drain or other exterior drainage is impractical, as shown on shop drawings, install low point drain stations in accordance with NFPA 13. Identify the location of drain and test stations with signs on access panels, ceiling panels, or walls adjacent to the station, visible from the floor. Riser main drains shall have hose bibb connections for maintenance drainage where drainage to exterior safe location is not allowed or impractical. Coordinate routing of drain lines to waste receptors. Direct interconnection shall not be made between sprinkler drain lines and sewers.
- E. Seismic protection for the piping system shall be in accordance with NFPA 13 standards and ASCE 7.
- F. Minimum 1-inch clearance for pipe and sprinkler heads at structural penetrations and between structural elements, equipment, hangers, supports, pipes, and fitted elements; coordinate with seismic requirements.
- G. Dry system piping shall be installed to allow full service and complete drainage of the entire system. Dry piping shall be sloped to accomplish this requirement. Discharge dry pipe drains to the outside. Drum drips shall be provided on exterior piping and interior areas subject to moisture accumulation.
- H. Pipe routing shall be coordinated to minimize visual impact and approved prior to installation. Piping shall not be concealed in walls.
- I. Provide penetrations where pipes pass through walls, floors, or ceilings. Penetrations shall be in accordance with UL Fire Resistance Directory for "Through Penetration Firestop Systems (XHEZ)".
- J. Piping supported from manufactured structural members shall comply with truss manufacturer's installation recommendations for hanger attachments and loading of pipe hangers.
- K. Pipe hangers attached to bar joist with wood top and bottom chords shall pre-drill chords for fasteners. The minimum distance for fasteners from truss "panel points" shall six inches or farther per manufacturer's recommendations.
- L. Pipe hangers: "Rod and ring" type hangers throughout for dry pipe system. Minimum 1/2 inch of adjustment on each side of the hanger ring nut, to allow for piping grade adjustment in the future.
- M. Install "beam clamp" type fasteners with retainer straps and locking nuts.
- N. Fasten trapeze members to truss chords or structural members.
- O. Provide service access around equipment per manufacturer's requirements, minimum of 18 inches.
- P. Provide clearance for removal of all sprinkler heads.

- Q. Drain line detailed adjacent to standpipe/sprinkler risers shall be consider as part of the sprinkler system from combination test/auxiliary drain valve for each zone or sub-zone to exterior discharge or plumbing receptacle.
- R. Discharge test connections inside building to plumbing receptacles.
- S. Provide test connection for each flow switch and tamper switch on each shutoff valve.

### **3.4 ELECTRICAL**

- A. Provide all electrical work, connections, routings, signals, power, and services as required by NFPA 72 and Division 26 requirements.
- B. Provide tamper switch at each shutoff valve.

### **3.5 ACCESS DOORS**

- A. Provide access doors where "Fire Protection" valves, switches, or other controlling or monitoring devices are concealed. Label doors for quick location and recognition of concealed devices. For rated assemblies provide rated access door to match assembly's rating.

### **3.6 INSPECTORS TEST PIPING**

- A. Discharge inspectors test piping to approved floor drains in non-public areas, or outside building, but not on main walkways or over architectural surfaces easily stained or difficult to clean. Do not terminate discharge more than 48 inches above grade. Discharge main test and drain piping used for service line flow testing outside and terminate with a hose connection.

### **3.7 FLUSHING AND TESTING**

- A. All sprinkler systems shall be arranged for flushing. Cross main ends shall be provided with readily removable fittings and shall terminate with 1-1/4" or larger pipe.
- B. Flush underground service piping and distribution piping before connecting underground piping to sprinkler system.
- C. Arrange for proper witnessing of tests, as required by Authority Having Jurisdiction and as specified elsewhere.
- D. Conduct tests in accordance with applicable codes. Test above ground and underground piping at minimum 200 psig hydrostatic for two hours. Flush as required by NFPA.
- E. Trip test dry pipe system to confirm system discharge time. Dry pipe systems shall produce water at inspector test within 60 seconds. Contractor shall provide an accelerator if required to meet discharge time requirements.
- F. Provide a letter of certification stating that testing and flushing has been performed in accordance with the applicable codes and standards. Itemize codes and standards complied with.
- G. Test system alarm actuations and alarm monitoring systems.
- H. Conduct backflow device full flow test and record inlet and discharge pressures and discharge flow.

### **3.8 DRY SPRINKLER HEADS**

- A. Provide dry sprinkler heads in areas potentially subject to freezing not protected by dry pipe sprinkler system including, but not limited to ceilings of entry vestibules, overhangs requiring fire protection, rooms with combustion air openings, walk-in freezers and refrigerators, and under over-head garage type doors.

### **3.9 PAINTING**

- A. All exposed sprinkler system and elements shall be painted, excluding sprinkler head assemblies.
- B. Clean and prepare all pipe, fittings, hangers, restraints, supports, and miscellaneous items for all areas to be painted.
- C. Refer to the requirements specified in Division 9.

### **3.10 SPRINKLER PIPING AT ELECTRICAL/TRANSFORMER ROOMS**

- A. Provide complete interface with electrical/transformer rooms in compliance with the National Electrical Code. Apply the following practices:
- B. Route no piping through electrical rooms except branch piping supplying sprinklers protecting the electrical room. Branch piping shall not exit the electrical room to supply additional sprinklers outside the room.
- C. No piping shall be routed above electrical panels.
- D. Baffles, as described in NFPA 13, shall be provided to deflect direct sprinkler discharge away from electrical panels.
- E. Maintain a minimum of 36 inches clear in front of electrical panels.

### **3.11 SPRINKLER PIPING AT TELECOM, DATA, AND COMPUTER ROOMS**

- A. Route no piping through telecom rooms except branch piping supplying sprinklers protecting the telecom room. Branch piping shall not exit the telecom room to supply additional sprinklers outside the room.
- B. No piping shall be routed above electrical panels or telecommunication racks.
- C. Baffles, as described in NFPA 13, shall be provided to deflect direct sprinkler discharge away from electrical panels.

### **3.12 ELEVATOR SHAFTS, PITS, AND EQUIPMENT ROOMS**

- A. Sprinklers in the elevator shaft and equipment room are not required, except a sprinkler is required within two feet of the bottom of the pit, or as required by the Authority Having Jurisdiction.

### **3.13 SPRINKLER HEAD INSTALLATION**

- A. Sprinkler heads to be centered in two directions on acoustical lay-in panels and symmetrically laid out in each separate room or space with GWB type ceiling regardless of finishes and minimum Code requirements.
- B. Sprinkler head temperature ratings shall be selected based upon installed distance from heat source.

### **3.14 GROOVED AND ROLLED FITTINGS**

- A. Follow the manufacturer's suggested methods to prepare gaskets, pipes and fittings to prevent leakage, system breakdown, and designed pipe and fitting movement. Welding fittings shall not be used on galvanized pipe.
- B. Schedule 40 galvanized pipe shall be used for grooved pipe and fittings.

### **3.15 DRY PIPE SYSTEM AIR MAINTENANCE AND APPURTENANCES**

- A. Provide all hardware necessary to mount compressor on floor adjacent to the dry pipe system valve assembly.
- B. Provide all piping and fitting necessary to connect to the systems.

- C. Coordinate connection of alarm contacts with Section 28 31 13 - Addressable Fire Alarm System.

**END OF SECTION 22 11 00**

**SECTION 22 11 00**  
**DOMESTIC WATER PIPING AND SPECIALTIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Pipe, fittings, and connections for domestic potable water system.
  - 2. Piping, fittings and connection for R.O. purified water
  - 3. Valves.
  - 4. Piping accessories.
  - 5. Indirect Water Heaters
  - 6. Electric Instantaneous water heaters.
  - 7. Hot water circulating pumps.
  - 8. Domestic hot water thermal expansion tank.
  - 9. Water meter.
  - 10. Water hammer arresters.
  - 11. Trap primer valves.
  - 12. Backflow preventers.
  - 13. Reverse Osmosis water purifier
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00- Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 07 00 - Mechanical Insulation
  - 6. 22 11 23 - Packaged Lift Station
  - 7. 22 14 00 - Sanitary Waste and Vent Piping
  - 8. 22 40 00 - Plumbing Fixtures and Equipment
  - 9. 23 05 53 - Mechanical Identification
  - 10. 23 05 93 - Testing, Adjusting and Balancing
  - 11. 23 21 23 - Motors
  - 12. 23 84 00 - Humidification Equipment
  - 13. 25 90 00 - Sequences of Operation

**1.2 REFERENCES**

- A. Uniform Plumbing Code (UPC).
- B. American National Standard A117.1 – (Latest Edition), Specifications for Making Buildings and Facilities Accessible and Usable by Physically Handicapped People.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the various plumbing systems and equipment.
- B. Performance Requirements:
  - 1. Provide performance and output shown or scheduled on drawings.
  - 2. Potable water systems shall perform quietly, with no vibration transmitted to the surrounding construction. Replace equipment that does not perform as intended with properly operating equipment.

#### 1.4 SUBMITTALS

- A. Refer to Section 20 00 00– Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.
  - 2. Indicate valve data and ratings.
  - 3. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings:
  - 1. Submit shop drawings for plumbing piping systems to demonstrate proper layout and coordination.
  - 2. Drawings of toilet rooms, science rooms, locker rooms and other areas with high-density piping shall be shown at 1/4-inch scale or larger.
  - 3. Indicate elevation of piping above finish floor.
  - 4. Show placement of fixtures and plumbing equipment.
  - 5. Indicate dimensions and weights of fixtures and equipment, and placement of openings and holes.
  - 6. Include reference to ductwork and other equipment where space coordination is necessary to avoid conflicts.
- D. Quality Control/Control Submittals:
  - 1. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - b. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      - 1). Printed names and signatures of the installers.
- E. Training: Reverse Osmosis Water System training syllabus, submit for approval.
- F. Documentation from Manufacturer's representative and the Department's Representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
  - 1. Provide test reports:
    - a. Provide certificate listing satisfactory results for the hydrostatic tests.
    - b. Provide certificate listing satisfactory results for sterilization of systems.
- G. Closeout Submittals:
  - 1. Project Record Documents: Record actual locations of valves, backflow preventers, water hammer arresters, other components, and locations of access doors required for access or valves.
  - 2. Operation and Maintenance (O&M) Manuals:
    - a. Provide copies of approved submittal information for inclusion within the project O&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.

#### 1.5 QUALITY CONTROL

- A. Qualifications:
  - 1. Manufacturer Qualifications:
    - a. Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

2. Acceptable Installers:
  - a. Minimum three years experience in the installation and start-up of plumbing systems and equipment.
- B. Startup Service:
  1. Provide startup of the reverse osmosis equipment by manufacturer authorized specialist.
- C. Pre-Installation Meetings:
  1. Fully coordinate installation of plumbing systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any plumbing components.
- D. Regulatory Requirements:
  1. Conform to applicable code for installation of backflow prevention devices.
  2. Provide certificate of compliance from the City and Borough of Juneau indicating approval of installation of backflow prevention devices.
  3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

## 1.6 TRAINING

- A. Reverse Osmosis System:
  1. Provide complete hands-on owner training for the operation and maintenance of reverse osmosis equipment by manufacturer authorized specialist, to include:
    - a. Theory of system operation.
    - b. Hands-on proper operation of system.
    - c. Hands-on recommended scheduled and preventative maintenance.
  2. Submit training syllabus for approval.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  1. Verify that products are delivered in original factory packaging and are free from damage and corrosion. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  1. Store products in covered storage area protected from the elements, outside the general construction zone until installed. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage. Replace damaged items with same item in new condition.

## 1.8 WARRANTY

- A. See Section 20 00 00 - Closeout Procedures.
- B. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty for products and materials provided by this .
- C. Provide to the Department's Representative one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

## PART 2 - PRODUCTS

### 2.1 WATER PIPING (BURIED WITHIN 5 FEET OF BUILDING)

- A. Copper Tubing: ASTM B42, hard drawn.
  1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
  2. Joints: ASTM B32, solder, Grade 95TA.
- B. Copper Tubing: ASTM B42, annealed:
  1. Fittings: ASME B16.26, cast bronze.

2. Joints: Flared.
- C. Continuation of water service into building:
  1. Pipe: AWWA C151, 4 inch and larger ductile iron pipe.
  2. Fittings: Ductile iron, standard thickness.
  3. Joints: AWWA C110, C153, mechanically restrained joints.
    - a. Trade name: Megalug.

## 2.2 WATER PIPING (ABOVE GRADE)

- A. Copper Tubing (hard drawn: .
  1. Tubing: ASTM B88, Type L.
  2. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  3. Joints: ASTM B32, solder, Grade 95TA.
- B. Copper Press Fitting System:
  1. Limited to tubing sizes 2" and smaller.
  2. Cast or wrought copper fittings, ASME B16.18 or ASME B16.22. Pre-formed grooves with pre-lubricated EPDM O-rings designed to seal fitting to copper tubing water tight with the use of manufacturer's crimping tool. Fittings shall be rated for 250 Degrees F., and 200 psi.
  3. IAPMO UPC listing.
  4. Manufacturer: Viega ProPress or equal.

## 2.3 RO WATER PIPING

- A. Pipe: Schedule 80 PVC conforming to ASTM D-1785 (Schedule 40 & Schedule 80) or ASTM D-2241 (SDR-26 & SDR-41) and listed by the National Sanitation Foundation (NSF) for potable water applications
- B. Fittings: PVC material which meets or exceeds the requirements of ASTM D-1784, cell classification 12454B, Type 1, Grade 1
- C. Valves: Full port ball type, PVC body, EPDM O-ring stem seal, EPDM Seat Seal, Socket or Threaded. Nibco or equal.
- D. Pipe adaptors: socket weld threaded or flanged,
- E. All solvent cements used, to conform to ASTM D-2564, listed by NSF for potable use applications.

## 2.4 VALVES (COPPER PIPING)

- A. Manufacturers:
  1. Crane
  2. Nibco
  3. Hammond
  4. Jenkins
  5. Grinnell
  6. Milwaukee
  7. Stockham
  8. Pre-approved equal.
- B. General:
  1. Select valves of the best quality and type suited for the specific service and piping system used. Minimum working pressure rating 125 psig saturated steam or 200 psig W.O.G. Packing material or seals shall not contain asbestos.

- C. Ball Valves:
  - 1. Two (2) inches and smaller: Two piece type, full port, bronze body and ball, TFE seats, blowout proof stem, 150 psig pressure/temperature rating (steam).
  - 2. Two and one half (2-1/2) inches through four (4) inch: Two piece type, full port, bronze body and ball, TFE seats, 150 psig pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.
- D. Gate Valves:
  - 1. Two (2) inches and smaller: Bronze body and trim, rising stem, solid wedge. Use only where shown on drawings.
  - 2. Two and one half (2-1/2) inches through four (4) inch: Iron-body, bronze trim, flanged threaded or sweat fitting. Non-rising stem: Inside screw. Rising stem: OS&Y. Bronze valves optional for 2-1/2 inch and three-inch.
- E. Globe Valves:
  - 1. Two (2) inches and smaller: Bronze body, renewable disc suitable for service.
  - 2. Two and one half (2-1/2) inches and larger: Iron body, bronze trim, flanged, bronze disc. Bronze valves optional for 2-1/2 inch and three-inch.
- F. Swing Check Valves:
  - 1. Two (2) inches and smaller: Bronze body, horizontal swing, Y-pattern, Buna-N-disc for water, oil and gas. TFE disc for steam.
  - 2. Two and one half (2-1/2) inches and larger: Iron body, horizontal swing, bolted bonnet, renewable bronze seat and disc, flanged.
    - a. Bronze valves optional for 2-1/2 inch and three (3) inch.
- G. Drain Valves: Full port ball valve with threaded hose adapter with bronze end cap. Do not use sillcocks or butterfly valves as drain valves.

## 2.5 ADAPTERS

- A. Use to connect pipes of same nominal size but different O.D.; cast iron to ductile iron etc., and where flexible connection is specified.
- B. Rigid sleeve type coupling, ductile iron center ring and end rings, elastomeric gaskets suitable for service, corrosion resistant bolts or polyethylene encasement. Romac brand, or approved equal.

## 2.6 FLEXIBLE AND EXPANSION COUPLINGS

- A. Flexible elastomeric or thermoplastic with stainless steel clamp bands, acceptable under plumbing code and to administrative authority. Fernco, Tech Specialties, or approved equal.

## 2.7 UNIONS (STANDARD)

- A. Steel Piping (Threaded):
  - 1. Class 150 malleable iron, ground joint, copper or copper alloy seat. Grinnell No. 463. (150 psig steam, 300 wog).
  - 2. Where indicated: Class 250 malleable iron ground joint, copper or copper alloy seat. Grinnell No. 554.
- B. Copper Piping (Sweat and Threaded): Cast brass, ground joint, copper to copper, or copper to threaded joint. Grinnell No. 9730 - 9739.

## 2.8 DIELECTRIC ISOLATORS (ELECTRICALLY INSULATING)

- A. Provide dielectric unions for two inch pipe and smaller.
- B. Provide dielectric flanges for 2-1/2 inch pipe and larger.
- C. Insulating gaskets, all types, shall be suitable for fluid type, temperature and pressure.
- D. Galvanized pipe to copper: Brass threaded end and sweat copper end.

- E. Black steel to copper: Zinc plated steel threaded end and sweat copper end.
- F. Manufacturers: Capitol, Epco, Control Plastics, Watts, or approved equal.

## **2.9 PIPELINE STRAINERS**

- A. Bronze Y-type to match pipe and fittings. Stainless steel screen with 0.045-in. diameter (36 percent open area) perforations or wire mesh.
- B. Provide isolating shutoff valves and drains at strainers.
- C. Manufacturers: Metraflex, Armstrong, Crane, Hayward, Watts Regulator, Hoffman, and Sarco.

## **2.10 PRESSURE GAUGES**

- A. Provide where shown on drawings, specified in Part 3, or as required.
- B. Bourdon tube type with 4-1/2-inch dial (minimum) accuracy plus or minus one-percent span, recalibratable. Normal operating pressure near midpoint of range. Industrial quality.
- C. Gauge cock on gauges and pulsation damper (snubber).

## **2.11 THERMOMETERS**

- A. Provide where shown on drawings, specified in Part 3, or as required.
- B. Liquid in glass type: Industrial quality red-reading with nine-inch scale length (minimum). Straight angle or adjustable as necessary for visibility.
- C. Dial Type: Industrial quality three-inch dial with 270 degrees (minimum) scale length. Straight, angle or remote as necessary for visibility.
- D. Normal operating temperature at scale midpoint and sufficient range to comfortably cover operating conditions.
- E. Provide separable wells of suitable material for piping. Set probe in heat transfer paste recommended by thermometer manufacturer.
- F. Manufacturers: Tserice, Marsh, Weksler, or approved equal.

## **2.12 PRESSURE AND TEMPERATURE TEST PLUGS**

- A. Provide where shown on drawings, specified in Part 3 or as required.
- B. Standard type for 1/8-inch diameter pressure or temperature probes. Self seal when probe removed and complete with threaded cap. Minimum continuous rating 125 psig and 220 degrees F. coincident. Sealing element suitable for fluid in pipe.
- C. Provide one thermometer and one pressure gauge for each range required by system parameters.
- D. Manufacturers: Sisco, Peterson Equipment, or approved equal.

## **2.13 INDIRECT WATER HEATERS FOR POTABLE WATER (WH-1, WH-2)**

- A. Provide an indirect-fired water heater of the size and capacity shown on the Drawings. Certify that the heater complies with the requirements of ASHRAE 90.1.
- B. Tank:
  - 1. 316L stainless steel reservoir.
  - 2. Maximum working pressure of 150 psi.
  - 3. Inlet and outlet connections at bottom.
  - 4. 3/4-inch tapping for relief valve.
  - 5. Accessories: ASME rated temperature and pressure relief valve.
- C. Polyethylene outer jacket, over CFC-free urethane foam insulation. Insulation thickness and efficiency shall be as required to meet energy efficiency requirements of ASHRAE 90.1.

- D. Heat Exchanger:
  - 1. Double wall finned copper with Stanoguard plating.
  - 2. Inlet and outlet heating pipe connections.
- E. Controls. Provide a complete and operating control system, including the following features:
  - 1. Electro-mechanical AquaStat temperature control.
  - 2. High temperature limiting device.
  - 3. UL approved controls, factory wired.
  - 4. Provide control wiring diagram.
- F. Manufacturer: Amtrol Boilermate WHS Series, or approved equal.

#### **2.14 INDIRECT WATER HEATERS FOR NON-POTABLE WATER (WH-3)**

- A. Provide performance characteristics as scheduled.
- B. Tank:
  - 1. Steel tank shell steel support stand.
  - 2. Enamel or urethane coating.
  - 3. Urethane insulation.
  - 4. Polyethylene liner..
  - 5. Bottom system connections.
  - 6. Temperature and pressure relief valve.
  - 7. Low point drain valve.
- C. Heat Exchanger:
  - 1. Single Wall finned copper with Stanoguard plating.
  - 2. Inlet and outlet heating pipe connections.
- D. Controls. Provide a complete and operating control system, including the following features:
  - 1. Electro-mechanical AquaStat temperature control.
  - 2. High temperature limiting device.
  - 3. UL approved controls, factory wired.
  - 4. Provide control wiring diagram.
- E. Manufacturer: Amtrol BoilerMate Classic Series or approved equal.

#### **2.15 ELECTRIC WATER HEATER (WH-4)**

- A. Storage type water heater as scheduled.
- B. Tank:
  - 1. Steel, glass lined with anode rod.
  - 2. ASME, 150 psi working pressure.
  - 3. Drain Valve.
  - 4. ASME T&P valve.
- C. Insulation: Foam insulation meeting or exceeding ASHRAE 90.1-2004 standby loss requirements.
- D. Enclosure: Bonderized sheet metal (Galvanized steel put through a phosphate bath and chromate drying process to accept paint) with backed enamel finish.
- E. Heating elements: single heavy duty medium watt density with zinc plated copper sheathing.
- F. Controls
  - 1. Factory wired adjustable 110 Deg F to 170 Deg F,
  - 2. Manual reset high temperature cutoff.
- G. UL listed.
- H. Three year warranty
- I. Manufacturer: State Water Heater (basis of design) or equal.

## 2.16 DOMESTIC HOT WATER CIRCULATING PUMPS

- A. General: System lubricated, in-line, single stage, flange or sweat connections, UL listed.
- B. Performance: Provide pumps of the size, type and capacity scheduled on the drawings.
- C. Housing: Silicone Bronze C875 or 304 stainless steel. 145 psig working pressure.
- D. Impeller: 304 stainless steel or PES composite (30% glass filled).
- E. Inlet cone, bearing plate, bearing retainers, rotor can, rotor cladding, shaft retainer: 304 stainless steel.
- F. Shaft, upper & lower radial bearings: Aluminum oxide ceramic.
- G. Thrust bearing: Metal impregnated carbon.
- H. Terminal Box: Noryl.
- I. Manufacturers:
  - 1. Grundfos UP series (Basis of Design).
  - 2. . B&G, Taco, Armstrong

## 2.17 DOMESTIC HOT WATER EXPANSION TANKS (ET-6)

- A. Tank:
  - 1. ASME stamped.
  - 2. Steel tank shell steel support stand.
  - 3. Enamel or urethane coating.
  - 4. NSF approved polypropylene liner.
  - 5. FDA approved replaceable butyl rubber bladder.
  - 6. Brass threaded system connection.
- B. Operating Characteristics:
  - 1. Maximum Working Temperature: 200 degrees F.
  - 2. Maximum Working Pressure: 150 PSIG.
  - 3. Tank Precharge: 40 PSIG.
- C. Manufacturer: Amtrol Therm-X-Trol (Basis of Design), Taco, or equal.

## 2.18 RO SYSTEM PRESSURE TANKS (PT-1, PT-2)

- A. Tank:
  - 1. Outer shell of fiberglass strands sealed with epoxy resin.
  - 2. Inner shell of molded HDPE.
  - 3. Replaceable Seamless full size blow molded air cell.
  - 4. Polymeric base.
  - 5. HDPE Bottom inlet.
- B. Operating Requirements
  - 1. Maximum operating pressure: 125 PSIG.
  - 2. Maximum operating temperature: 100 Deg F.
  - 3. Tank Precharge: 36 PSIG.
  - 4. Draw down: minimum 22.5 gallons from 60 to 40 PSIG with 36 PSIG precharge.
- C. Manufacturer: Well Mate WM 25WB or equal.

### **2.19 WATER METER**

- A. Provide flow monitoring water meter for Building Automation System connection as shown on drawings. Full flow, turbine type with magnetically driven register and contact type pulse transmitter.
- B. Manufacturers:
  - 1. Badger.
  - 2. Hersey
  - 3. Kent
  - 4. Neptune.

### **2.20 WATER HAMMER ARRESTERS**

- A. Provide stainless steel balanced expansion bellows type or pressurized piston type water hammer arresters where shown. Provide size noted.
- B. Manufacturers: Bellows Type: J.R. Smith "Hydrotrol", Zurn "Shoktrol", MIFAB WHB series, or approved equal. Piston Type: Sioux Chief, Precision Plumbing Products, Inc., MIFAB MWH series, or approved equal.

### **2.21 TRAP PRIMER VALVES**

- A. Valves shall be factory set for proper operation with a pressure drop of 3 psi and system water pressure of 35 to 70 psi.
- B. Manufacturers: Precision Plumbing Products, Model "PR-500", MIFAB Model "MR-500", or approved equal.

### **2.22 ELECTRONIC TRAP PRIMER VALVES**

- A. Electronically controlled trap primer valve for areas where mechanical differential pressure type primer valves are not suitable.
- B. Features
  - 1. 120V power supply, circuit breaker, test switch, timer solenoid valve, UL listed.
  - 2. Air gap fitting, distribution unit for multiple traps as required.
  - 3. Surface mounted cabinet with removable cover.
- C. Manufacturers: Precision Plumbing Products, Model "MPB-500-115V", or approved equal.

### **2.23 DOUBLE CHECK VALVE ASSEMBLY BACKFLOW DEVICE**

- A. The double check valve assembly backflow-preventer shall consist of two independently operating, spring loaded cam-check valves, required test cocks, and inlet and outlet resilient seat shut off valves.
- B. The cam-checks include a stainless steel spring and cam-arm, rubber faced disc, and a replaceable seat. The body shall be manufactured from 300 series stainless steel, lead free, with a single two-bolt grooved style access cover. No special tools shall be required for servicing.
- C. Provide installation that meets access requirements of local code amendments.
- D. Water pressure drop through the assembly including shutoff valves shall not exceed five PSIG at 150 GPM.
- E. Manufacturer: AMES model 2000 SS (Basis of design), Watts Regulator, Febco.

**2.24 REDUCED PRESSURE PRINCIPAL BACK FLOW DEVICE**

- A. The reduced pressure backflow preventer shall consist of two independently operating, spring loaded cam-check valves with a hydraulically operated differential pressure relief valve located between and below the cam-checks, required test cocks, and inlet and outlet resilient seat shut off valves.
- B. Modes of Operation:
  - 1. When normal flow exists, both check valves are open and the pressure in the area between the checks, called the zone, is at least two PSI lower than the inlet pressure. The differential pressure relief valve is closed during normal flow.
  - 2. If cessation of normal flow occurs, the differential pressure relief valve will automatically open and discharge to maintain the zone at least two PSI lower than the inlet pressure. This action will prevent a backflow or back siphonage condition. After the required differential is established, the differential pressure relief valve again closes.
- C. The cam-checks include a stainless steel spring and cam-arm, rubber faced disc, and a replaceable seat. The body shall be manufactured from 300 series stainless steel, lead free, with a single two-bolt grooved style access cover. No special tools shall be required for servicing. The relief valve shall be compact with a rolling diaphragm and no sliding seals. The relief valve shall discharge in a 360 degree radius.
- D. Provide installation that meets access requirements of local code amendments.

E. Performance Requirements:

Size	Max pressure drop at Flow Through Assembly	Max Relief valve Discharge rate at inlet pressure.
3/4"	14 PSI at 20 GPM	40 GPM at 80 PSI
1"	13 PSd at 50 GPM	35 GPM at 80 PSI

- F. Manufacturer: Watts Regulator LF009 (basis of design), AMES model 4000SS series, Febco, or equal.

**2.25 REVERSE OSMOSIS WATER SYSTEM (RO-1, RO-2)**

- A. Packaged water purification system to remove impurities from potable water utilizing pressure pumps to force potable water reverse osmosis membranes, single pass configuration.
- B. Provide the following features:
  - 1. UL Listed Controls
  - 2. Minitrol Controller
    - a. Multi color LED indicator status lights
    - b. Pre-treatment lockout.
    - c. Tank Level Input
    - d. Low Pressure Monitoring and Alarm.
  - 3. White powder coated aluminum frame.
  - 4. 5 micron sediment filter.
  - 5. 10 micron Carbon Black prefilter
  - 6. 1 micron Sediment Pre-filter
  - 7. Filter housings with double o-ring seals.
  - 8. Multi-stage stainless steel booster pump.
  - 9. HF-5 ultra low pressure membranes – two (2).
  - 10. PVC pressure vessels– two (2).
  - 11. Permeate flow meter.
  - 12. Concentrate flow meter.

13. Feed low pressure switch.
  14. Feed Solenoid valve with manual bypass.
  15. 316 stainless steel concentrate valve
  16. 0-300 psi pump pressure gauges
  17. 0-100 psi prefilter pressure gauges
  18. HM digital PS-100 TDS controller
- C. Capacity requirements:
1. 1" connection, 1" permeate and 1" concentrate.
  2. 3.8 GPM and 40 Deg F incoming raw water.
  3. 1.7 gpm minimum permeate flow rate at 60 psi discharge.
  4. 2.1 gpm minimum concentrate flow rate.
  5. Pump flow: 7 gpm minimum flow, 9 gpm maximum flow.
  6. 45% recovery rate.
  7. 98.5% salt rejections.
- D. Pump: Multistage Stainless steel, 3450 RMP 1-1/2 HP, 480V, 3PH, 3.5 Amps
- E. System Dimensions: 30" L x 38" W x 47" H.
- F. Manufacturer: Axeon Water Technologies Flexion Reverse Osmosis CT4000P System or equal.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection:
1. Cover equipment and plug piping connections to protect components from construction dirt and debris.
- B. Surface Preparation:
1. Verify that excavations are to required grade, dry, and not over-excavated. See Division 2 – Existing Conditions.

#### **3.2 INSTALLATION**

- A. Install plumbing products in accordance with manufacturer's instructions.
- B. Provide finished products with protective covers during balance of construction.
- C. Access Doors: Provide appropriate size access doors and install such that plumbing features are readily accessible and maintainable. Provide rated access doors as applicable.
- D. Provide accessible ball valves for isolation service at major piping branches and on main lines to facilitate isolation and draining of discreet sections of the water system to simplify maintenance. Provide high point vents and low point drains with capped hose bibbs such that each section of the piping system can be fully drained.
- E. Install balancing valves for hot water recirculation system to be accessible and adjustable.
- F. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. At fixtures, install and connect hot water on left and cold water on right, as viewed when facing the fixture.
- I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Provide support for utility meters in accordance with requirements of utility companies.

- L. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish Painting. Refer to 09 90 00 – Painting and Coating.

### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
  - 2. Fully coordinate and sequence installation of plumbing products with trades responsible for portions of this and other related sections of the Project Manual.
  - 3. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Department.

### **3.4 REPAIR / RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FCT checklists in accordance with Section 01 91 00 – Commissioning.
- B. Site Tests:
  - 1. Test water piping hydrostatically at 100 psig or 150 percent of working pressure, whichever is greater, for a period of four hours. Observe piping during this period and repair leaks and retest.
  - 2. Air Test:
    - a. In general, air testing is not acceptable. In the event of low temperature conditions that would subject system piping to freezing, an equivalent air pressure test may be conducted in accordance with the Uniform Plumbing Code with prior Department's Representative approval.
    - b. Test with clean air at 150 percent of system working pressure but not less than 75 psig or more than 150 psig. System shall hold pressure for not less than four hours. Inspect joints using leak detecting fluid or soapy water. Repair leaks and retest.
    - c. Observe necessary safety procedures when testing with air including, but not limited to, use of protective goggles or face shields. Only persons directly involved in testing procedure shall be with 20 feet of a pipe under pressure.
  - 3. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and the Department's Representative witnessing the test.
- C. Inspection:
  - 1. Arrange for inspections and provide notice to the Administrative Authority when the entire work or logical portions thereof, is ready for inspection.
- D. Manufacturer's Field Services:
  - 1. Verify units are installed and operational in accordance with the manufacturer's written installation instructions.
  - 2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper unit installation and operation.

### **3.6 ADJUSTING**

- A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

### **3.7 CLEANING**

- A. Sterilization of Domestic Water Systems:
  - 1. Sterilize each unit of completed supply line and distribution system with chlorine before acceptance for domestic operation.
  - 2. Sterilization as described below or by the system prescribed by the American Water Works Association Standard C-651. Apply the amount of chlorine to provide a dosage of not less than 50 parts per million. Provide chlorine manufactured in conformance to the following standards:
    - a. Liquid Chlorine: Federal Specification BB-C-120.
    - b. Hypochlorite: General Specification O-C-114a, type 11, Grade B or Federal Specification O-X-602.
  - 3. Introduce the chlorinating material to the water lines and distribution system after piping system has been thoroughly flushed. Maintain a contact period of not less than 24 hours. Flush the system with clean water until the residual chlorine content is not greater than 1.0 part per million.
  - 4. Open and close valves in the lines being sterilized several times during above chlorination.
  - 5. Certify in writing that sterilization has been completed in accordance with these requirements.

### **3.8 SYSTEM STARTUP**

- A. Start-up and operate domestic water system in accordance with the manufacturer's written installation, operation and maintenance manuals where applicable.
- B. Provide startup reports for the Reverse Osmosis water purification systems. Startup service shall be performed by a factory trained and authorized technician.
- C. Verify proper operational sequences in accordance with Section 25 90 00 – Sequence of Operation.

### **3.9 ADJUSTING**

- A. Test, adjust and balance domestic water system in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner. Document hot water recirculation balance valve settings in valve directory.

**END OF SECTION 22 11 00**

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**SECTION 22 11 23**  
**PACKAGED LIFT STATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Packaged Sewage Lift Station.
- B. Lift Station products Not Provided Under This Section.
  - 1. Cast Concrete Sump. Refer to Article 3.1
- C. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 53 - Mechanical Identification
  - 4. 22 14 00 - Sanitary Waste and Vent Piping
  - 5. 23 21 23 - Motors
  - 6. 25 50 00 - Building Automation and Control
  - 7. 25 90 00 - Sequences of Operation

**1.2 REFERENCES**

- A. Uniform Plumbing Code.

**1.3 SYSTEM DESCRIPTION**

- A. Provide a complete and operational packaged sewage lift station as shown and scheduled to include: Wapor tight cover (with access and pipe/conduit penetrations) installed on a cast concrete sump; duplex grinder pumps and associated appurtenances; duplex pump controller with Disconnects.
- B. Provide connection to building automation system to lift station High Water alarm.
- C. Provide waste and vent connections as shown and specified.

**1.4 SUBMITTALS**

- A. Product Data: Submit product data for each Packaged Lift Station component to demonstrate compliance with the Contract Documents. Product submittal to include:
  - 1. Dimensioned cover/access frame detail fully coordinated with cast concrete sump.
  - 2. Pump Outline Drawing.
  - 3. Control Panel Drawing and Data.
  - 4. Pump Performance Curves.
  - 5. Electrical Motor Data.
  - 6. Installation, Operation and Maintenance Instructions. Coordinate sump installation instructions with Civil.
  - 7. Parts List.
  - 8. Printed Warranty.
  - 9. Manufacturer's Equipment Storage Recommendations.
  - 10. Manufacturer's Standard Recommended Start-Up Report Form.
- B. Shop Drawings: Submit plan and section shop drawings which clearly show the intended installation of the package lift station to include sump, lid, grinder pumps, pump guide rail assemblies, internal piping, valving and exterior service pipe connections, conduit, control panels and Disconnects and interface with adjacent systems and work.
- C. IO&M Manuals: Include:
  - 1. System design information sheet.
  - 2. Description of system operation.

3. Packaged system dimension and general arrangement drawing.
  4. Electrical power and control wiring diagram.
  5. Bill of material.
  6. Installation instructions.
  7. Pump operation and maintenance instructions.
  8. Any special electrical component operation instructions.
- D. Certificates: Submit certificate from the manufacturer's representative that the system is installed in accordance with the manufacturer's installation instructions, and that the system is operating properly.
- E. Qualifications
1. Submit manufacturer qualifications, showing compliance with Article 1.5.
- F. Closeout Submittals:
1. Submit completed and signed Start-up Report Form documenting that Field Quality Control Services and System Demonstration have been satisfactorily completed to the Department's Representative's satisfaction.

### 1.5 QUALITY CONTROL

- A. The manufacturer shall have a minimum of ten (10) years manufacturing and application experience.
- B. Control logic panels listed by Underwriters Laboratories (UL).
- C. Pumps shall bear the UL or ETL listing and label before shipment from the factory.

### 1.6 WARRANTY

- A. See Section 20 00 00 – Mechanical General Requirements.

## PART 2 - PRODUCTS

### 2.1 SUMP AND APPURTENANCES

- A. Sump is provided under Structural and will be nominally 42 inch x42 inch ID x 78 " Deep.
- B. Pedestrian rated aluminum lid with the following:
1. Nominal lid dimension will be 50 inch x50 inch. Field verify dimensions and attachments prior to fabrication.
  2. Vapor tight access opening with hinged lid and latches.
  3. Two (2) 3.1 inch pump discharge openings with grommets for 2 inch Sched 40 Discharge pipe.
  4. Two (2) 1 inch NPT for pump power cord.
  5. One (1) 1-1/2 inch level sensor opening.
  6. One (1) 2 inch NPT vent fitting.
- C. Fittings and accessories as follows:
1. Two (2) 2 inch pump discharge pipe grommets: AKP# 124-0548
  2. Two (2) 2 inch NPT pump discharge elbows: AKP#4865501
  3. Two (2) inch schedule 40 Type 316 stainless steel pump discharge piping.
  4. Two (2) 2 inch ball check valves: Danfoss Flomatic AKP# 126-9956
  5. Two (2) Type 316 stainless steel upper guide rail brackets: AKP# 126-2102.
  6. Three quarter (3/4) inch schedule 40 Type 316 stainless steel pump guide rails.
  7. Two (2) 2-1/2 inch cast iron pump discharge fittings: Flygt, Model AKP# 126-2102
  8. Two (2) 2 inch bronze pump isolation valves: Kitz AKP# 022-2065
  9. Type 316 stainless steel pump lift chain and lift shackles sufficient to remove pumps from sump.
  10. Level sensor mounting fittings.
  11. Vapor tight cord fittings for pump power chords.

## 2.2 LIFT STATION GRINDER PUMPS

### A. Pump Type:

1. Heavy duty, electric submersible, centrifugal non-clog units specifically designed for handling raw, unscreened sewage and wastewater. Each pump shall contain special cutters to reduce sewage to a fine slurry.
2. Designed for continuous duty handling pumped media of 104°F and capable of up to 15 evenly spaced starts per hour.
3. Pump and motor suitable for continuous operation at full nameplate load while motor is completely or partially submerged or totally non-submerged.
4. Pump, mechanical seals and motor units provided from the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.
5. The pump system including the pump, motor and power cable shall be approved for use in areas classified as hazardous locations in accordance with the NEC Class I, Div. 1, Group C and D service as determined and approved by a U.S. nationally recognized testing laboratory (U.L., FM, CSA) at the time of the bidding of the project.

### B. Materials:

1. Pump Body: Cast iron, with ANSI flanged connections.
2. Impeller: Cast iron, dynamically balanced, single shrouded design capable of handling fine slurry from special cutters. Coated with an acrylic dispersion zinc phosphate primer.
3. Stationary cutter: Hardened Type 316 "L" stainless steel.
4. Rotary cutter: Chrome alloyed cast iron.
5. Metal surfaces coming in contact with pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the pump exterior.
6. Exposed nuts and bolts: Type 304 stainless steel.
7. Bearings: Two permanently grease lubricated shaft bearings to include single deep groove ball bearing upper bearing and two row angular contact lower bearing to compensate for axial thrust and radial forces.
8. Shafts: Common Type 431 stainless steel pump/motor shaft.
9. Shaft Seal Assemblies:
  - a. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact on four sides without a specific torque limit.
  - b. Rectangular cross sectional gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

### C. Performance:

1. As scheduled.

### D. Motor Characteristics:

1. Voltage/Phase as scheduled.
2. NEMA B design, induction type motor with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber.
3. Stator windings insulated with moisture resistant Class H insulation rated for 356 Deg F.
4. Stator thermal switches set to open at 260°F embedded in stator lead coils to monitor phase winding temperatures. Thermal switches used in conjunction with and supplemental to external motor overload protection and connected to pump control panel.
5. Stator chamber leakage monitor consisting of a small float switch (FLS) used to detect the presence of water in the stator chamber. When activated, the FLS sends an alarm to pump control panel and, if selected, stops pump motor.
6. Hermetically sealed junction chamber (contains terminal board).

- E. Cable Seal:
  - 1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal.
  - 2. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top.
- F. Manufacturers: Flygt (Basis of Design) or pre-approved equal.

### **2.3 CONTROL PANEL**

- A. Duplex pump control panel designed for two (2) lift station grinder pumps as specified to include the following:
  - 1. UL 508 listed intrinsically safe for MultiTrode level sensor inputs.
  - 2. Dead front NEMA 4 steel cabinet.
  - 3. Pump and control circuit Disconnects: Square D, FAL Series.
  - 4. Motor starters and pump heater overloads.
  - 5. Incoming power surge protection.
  - 6. High/Low voltage, Loss of Phase and Phase Reversal monitor with Run Inhibit in Auto and Manual control positions.
  - 7. Condensate heater with thermostat.
  - 8. High Water dome light with flasher.
  - 9. High Water auxiliary contracts.
  - 10. Pump alternator.
  - 11. Ten segment LED sump level display.
  - 12. Pump HAND-OFF-AUTO control switches: Square D NEMA 4.
  - 13. Pump RUN pilot lights.
  - 14. Pump run elapsed time meters.
  - 15. Stator moisture and overload monitor (one for each pump): Flygt, MiniCas.

### **2.4 SUMP LEVEL SENSOR**

- A. Ten (10) point, level sensor, support bracket, length to suit sump depth. Adequate cable to connect to control panel.
- B. Manufacturer: MultiTrode Stick 2.0/10-30, AKP# 1441009 or pre-approved equal.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Site verify that the sump dimensions prior to fabrication of sump lid. Refer to Structural drawings for sump installation.
- B. Inspect sump for damage and repair in accordance with factory recommended repair procedures if required.
- C. Verify that the sump lid when installed is vapor tight.

### **3.2 PROTECTION**

- A. Cover and protect system components from construction debris and damage due to adjacent work at all times.

### 3.3 INSTALLATION

- A. Install lift station components in accordance with approved shop drawings and manufacturers written installation instructions.
- B. Mount grinder pumps using a guide bar mounting arrangement with base mounted discharges. Pumps shall be installed such that they automatically and firmly connect to the discharge connections (machined metal to metal watertight contact) when lowered, guided by two guide bars per pump extending from the inside top of the sump to the sump base mounted discharge connections. There shall be no need for personnel to directly enter the wet sump for pump maintenance. No portion of the pumps shall bear directly on the sump floor.
- C. Adjust operating levels as indicated under ADJUSTING.
- D. Coordinate connection of "High Water" auxiliary alarm contacts to building automation system.

### 3.4 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Factory Startup Service: Provide the services of a qualified factory trained manufacturer's field service representative on site to inspect and test the installation. After the pumps have been installed and wired, the field service technician shall:
  - 1. Megger stator and power cables.
  - 2. Check seal lubrication.
  - 3. Check for proper pump rotation.
  - 4. Check power supply voltage.
  - 5. Measure motor operating load and no load current.
  - 6. Check level control operation and sequence.
  - 7. Review recommended operation and maintenance procedures with the Department's Representative.

### 3.5 ADJUSTING

- A. Adjust lift station level sensors as follows:
  - 1. Pumps Off: Refer to Drawings
  - 2. Lead Pump Start: Refer to Drawings
  - 3. Standby Pump Start: Refer to Drawings
  - 4. High Sump Level Alarm: Refer to Drawings
  - 5. Six (6) Inch Waste Invert: Refer to Drawings
  - 6. Four (4) Inch Vent Invert: Refer to Drawings

### 3.6 SEQUENCE OF OPERATION

- A. Start lead pump PMP-15A when sump water level reaches lead pump start level.
- B. If the water level continues to rise, start standby pump PMP-15B when the sump water level reaches the standby pump start level.
- C. If water level still continues to rises, close alarm contacts when the level reaches the "High Water" alarm level.
- D. When water level falls below the alarm level, open "High Water" level alarm contacts.
- E. As water continues to fall, stop standby pump PMP-15B when water level falls to the lead pump PMP-15A start level.
- F. Stop lead pump when water level falls to pumps off level.
- G. Alternate lead/standby pumps after each "both pumps off" event.

**3.7 CLEANING**

- A. Prior to system demonstration, thoroughly flush and clean lift station sump, sump lid and associated piping and components. Clean controllers (inside and outside). Replace enclosure filters if fouled with construction debris.

**3.8 DEMONSTRATION**

- A. Demonstrate proper operation of the system to the Department's Representative to include;
  - 1. Fill sump and verify pumps start/stop at the appropriate sump levels as indicated.
  - 2. Raise and lower each pump using the installed guide rail system to verify proper operation.
  - 3. Operationally test each pump and level alarm utilizing the packaged pump controller.
  - 4. Verify remote indication of system alarm utilizing the building automation system.
- B. Submit completed and signed Start-up Report Form documenting that System Demonstration has been satisfactorily completed to the Department's Representative's satisfaction.

**END OF SECTION 22 11 23**

**SECTION 22 14 00**  
**SANITARY WASTE AND VENT PIPING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Piping, pipe fittings, and connections for sanitary drain, waste and vent systems.
  - 2. Cleanouts.
- B. Related Sections:
  - 1. 13 48 00 - Vibration and Seismic Control
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 29 - Hangers and Supports
  - 4. 20 05 53 - Mechanical Identification
  - 5. 20 07 00 - Mechanical Insulation
  - 6. 22 11 23 - Packaged Lift Station

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. Uniform Plumbing Code (UPC).
- C. American National Standard A117.1 – (Latest Edition), Specifications for Making Buildings and Facilities Accessible and Usable by Physically Handicapped People.
- D. ASTM F1673-04 Standard Specification for Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems
- E. ASTM A888 - 11 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
- F. ASTM C1540 - 11 Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings
- G. ASTM C564 - 11 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
- H. ASTM B306 - 09 Standard Specification for Copper Drainage Tube (DWV)
- I. CISPI 301 Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. This section describes specific requirements, products and methods of execution for DWV plumbing systems and equipment.
- B. Performance Requirements:
  - 1. Provide products with performance, output or salient features shown or scheduled on drawings.
  - 2. DWV systems shall perform quietly, with no vibration transmitted to the surrounding construction. Replace equipment that does not perform as intended with properly operating equipment.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.

- B. Product Data:
  - 1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Clearly annotate literature to indicate specified salient features and performance criteria.
  - 2. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings:
  - 1. Submit shop drawings for plumbing DWV piping systems to demonstrate proper layout and coordination.
  - 2. Indicate elevation of piping below finish floor at various locations, in sufficient detail to demonstrate clearance from structural elements and the work of other trades. Indicate pipe grade and direction of slope. Indicate elevation of piping at the beginning and end of each main, and at branch connections.
  - 3. Show placement of fixtures and plumbing equipment.
  - 4. Indicate fixtures and equipment, and placement of openings and holes.
  - 5. Include reference to other equipment where space coordination is necessary to avoid conflicts.
- D. Quality Control/Control Submittals:
  - 1. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      - 1). Printed names and signatures of the installers.
      - 2). Documentation from Manufacturer's representative and the Department's Representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
  - 2. Provide test reports:
    - a. Provide certificate listing satisfactory results for pressure tests.
    - b. Provide certificate listing satisfactory results for flushing of systems.
- E. Closeout Submittals:
  - 1. Project Record Documents: Record actual dimensioned locations for buried or inaccessible piping. Show actual cleanout locations and types.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  - 1. Work shall be performed by workmen usually employed and experienced with the trade.
- B. Pre-Installation Meetings:
  - 1. Coordinate installation of plumbing systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any plumbing components.
- C. Regulatory Requirements:
  - 1. 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
3. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. See 20 00 00 - Mechanical General Requirements

## PART 2 - PRODUCTS

### 2.1 SANITARY DRAINAGE PIPING (BURIED WITHIN 5 FEET OF THE BUILDING)

- A. Cast Iron Pipe: ASTM A 888, CISPI 301 service weight.
- B. Fittings: DWV no-hub Cast iron.
- C. Joints:
  1. Meets ASTM C-1540 standard for heavy duty shielded couplings.
  2. Type 304 stainless steel shield and clamp assembly.
  3. Elastomeric gasket conforming to ASTM C 564.
  4. Sizes 1-1/2" through 4" diameter: 3" wide shield and 4 clamps.
  5. Sizes 5' through 10" diameter: 4" wide shield with 6 clamps.
  6. Manufacturer: Anaco-Husky or equal.

### 2.2 SANITARY DRAIN AND VENT PIPING (ABOVE GRADE)

- A. Cast Iron Pipe: ASTM A 888, CISPI 301 service weight.
  1. Fittings: DWV no-hub Cast iron.
  2. Joints:
    - a. Meets ASTM C-1540 standard for heavy duty shielded couplings.
    - b. Type 304 stainless steel shield and clamp assembly.
    - c. Elastomeric gasket conforming to ASTM C 564.
    - d. Sizes 1-1/2" through 4" diameter: 3" wide shield and 4 clamps.
    - e. Sizes 5' through 10" diameter: 4" wide shield with 6 clamps.
    - f. Manufacturer: Anaco-Husky or equal.
- B. Copper Pipe: Type DWV, ASTM B306.
  1. Fittings: ASME B16.23 cast bronze, or ASME B16.29 wrought copper.
  2. Joints: ASTM B32, solder, Grade 50B.
- C. Copper Pipe: Type L, ASTM B88.
  1. Fittings: ASME B16.23 cast bronze, or ASME B16.29 wrought copper.
  2. Joints: ASTM B32, solder, Grade 50B.

### 2.3 ACID RESISTANT WASTE

- A. Piping and fittings:
  1. Schedule 40 Polyvinylidene Fluoride (PVDF).
    - a. Complies with ASTM F1673,
    - b. UL mark to comply with UL 723 (ASTM E84).
    - c. Flame Spread 0-5, Smoke contributed 35.
- B. Joints: No-hub couplings
  1. 300 series stainless shield and bands.
  2. Nuts and bolts meet 500 hour salt spray test per ASTM B117. PVDF
- C. Manufacturers: Orion Fittings or equal.

### 2.4 REVERSE OSMOSIS/HUMIDIFIER DRAINS:

- A. Schedule 80 PVC or CPVC pipe and fittings.

## 2.5 ADAPTERS

- A. Use to connect pipes of same nominal size but different outside diameter, or pipes of different material (cast iron to ductile iron, etc.).
- B. Rigid sleeve type coupling, ductile iron center ring and end rings, elastomeric gaskets, corrosion resistant bolts or polyethylene encasement.
- C. Manufacturers: Romac, or approved equal.

## 2.6 FLEXIBLE AND EXPANSION COUPLINGS

- A. Flexible elastomeric or thermoplastic couplings with stainless steel clamp bands.
- B. Manufacturers: Fernco, Tech Specialties, or pre-approved equal.

## 2.7 CLEANOUTS

- A. Floor Cleanouts:
  - 1. Fixture: Cast iron body, bronze plug with neoprene gasket. Adjustable head to match finished floor elevation.
  - 2. Top: Square, scoriated bronze in areas with square tile. Round, scoriated bronze in areas with vinyl, concrete or non-square tile. Where indicated, provide cleanout tops with tile-terrazzo insert or flooring insert to match surrounding floor finish.
- B. Wall Cleanouts:
  - 1. Fixture: Cast iron body, recessed bronze plug.
  - 2. Cover: Wall access panel or access cover with center screw.
- C. Yard Cleanouts:
  - 1. Fixture: Cast iron body, bronze plug with neoprene gasket.
  - 2. Heavy duty access frame with anchor flanges and secured cover, fully surrounding and independent of cleanout.
- D. Manufacturers: J.R. Smith, Josam, Zurn, MIFAB.

## 2.8 EXTERNAL PIPE ELECTRIC HEAT TRACE

- A. External type heat trace UL listed for the application.
- B. Self-regulating heating cable consisting of two (2) 16 AWG nickel-coated copper bus wires embedded in a self-regulating polymer core
- C. Tinned copper braid around insulation with a protective jacket of a UV resistant polymer suitable for environmental exposure and maximum temperature expected
- D. Power output to respond to temperature: nominally 5 watts per foot at 50 Deg F and 2 watts per foot at 105 Deg F.
- E. ½" bend radius
- F. Manufacturer's connection kits.
- G. Raychem XL Trace 5xl-CR (120V) or equal.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection:
  - 1. Cover equipment and plug piping connections to protect components from construction dirt and debris.
- B. Surface Preparation:
  - 1. Verify that excavations are to required grade, dry, and not over-excavated. See Division 2 – Existing Conditions.

### 3.2 INSTALLATION

- A. Install plumbing products in accordance with manufacturer's instructions and approved shop drawings.
- B. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- C. Provide clearance from structure for installation of insulation and access to fittings.
- D. Interior Waste and Vent Piping – Above Ground:
  - 1. Grading: Grade as indicated on drawings or as specified above.
  - 2. Connections:
    - a. Hub and hubless piping joints as specified above for underground piping.
    - b. Thread Joints: Assemble with TFE tape or approved non-hardening joint compound.
    - c. Solder Joints: Assemble with lead free solder unless lead/tin solder is specifically approved in writing. Solder containing lead shall be stored separately from lead free solder and clearly identified for use on drainage pipes only.
    - d. Grooved and other joints: Assemble in accordance with manufacturer instructions.
- E. Vents:
  - 1. Install vents as indicated and as required by plumbing code. Add vents when field conditions increase the length of a trap arm or cause other changes in venting requirements.
- F. Cleanouts:
  - 1. Provide as indicated.
  - 2. If field conditions create additional offsets or increase length of piping shown, provide additional cleanouts as required by UPC.

### 3.3 CONSTRUCTION

- A. Interface with Other Work:
  - 1. Confirm location and size of fixtures and openings before rough-in and installation.
  - 2. Coordinate and sequence installation of plumbing products with trades responsible for portions of this and other related sections of the Project Manual including Civil.
  - 3. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Department.

### 3.4 REPAIR/RESTORATION

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### 3.5 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Site Tests:
  - 1. Water Test:
    - a. Test drainage and venting system with water in accordance with the Uniform Plumbing Code.
  - 2. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and the Department's Representative members witnessing the test.

C. Inspection:

1. Arrange for inspections and provide notice to the Department's Representative when the entire work or logical portions thereof, is ready for inspection.

**3.6 CLEANING**

- A. Clean and flush DWV piping, waste traps and floor drains to remove dirt and foreign debris.
- B. Provide written certification that the sanitary waste system has been flushed of foreign debris. Include date and printed names and signatures of person(s) performing the flush and the Department's Representative members witnessing the flush.

**END OF SECTION 22 14 00**

**SECTION 22 14 23**  
**STORM DRAINAGE PIPING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Pipe, pipe fittings, and connections for storm water piping systems.
  - 2. Cleanouts.
  - 3. Access doors.
  - 4. Trench Drains
  - 5. Roof drains.
  - 6. Electric heat trace.
- B. Related Sections:
  - 1. Division 2 - Existing Conditions
  - 2. 08 31 00 - Access Doors and Panels
  - 3. 09 90 00 - Painting
  - 4. 13 48 00 - Vibration and Seismic Control
  - 5. 20 00 00 - Mechanical General Requirements
  - 6. 20 05 29 - Hangers and Supports
  - 7. 20 05 53 - Mechanical Identification
  - 8. 20 07 00 - Mechanical Insulation
  - 9. 22 40 00 - Plumbing Fixtures
  - 10. 31 20 02 - Trenching

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. Uniform Plumbing Code (UPC).

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements: This section describes specific requirements, products and methods of execution for storm drainage systems and equipment.
- B. Performance Requirements:
  - 1. Provide products with performance, output or salient features shown or scheduled on drawings.
  - 2. Rain leader and storm drain systems shall perform quietly, with no vibration transmitted to the surrounding construction.
  - 3. Replace piping that does not perform as intended with properly operating equipment.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Clearly annotate literature to indicate specified salient features and performance criteria.
  - 2. Indicate valve data and ratings.
  - 3. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.
- C. Fabrication Data: Submit the computer record for each fabricated HDPE fitting.

- D. Shop Drawings:
  - 1. Submit shop drawings for storm drainage systems to demonstrate proper layout and coordination.
  - 2. Indicate elevation of piping above or below finish floor at various locations in sufficient detail to demonstrate clearance from structural elements and the work of other trades. Indicate pipe grade and direction of slope. Indicate elevation of piping at the beginning and end of each main, and at branch connections.
  - 3. Coordinate exact locations of roof drains, floor penetrations and structural penetrations with applicable trades.
  - 4. Include reference to ductwork and other equipment where space coordination is necessary to avoid conflicts.
- E. Quality Control/Control Submittals:
  - 1. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment.
    - b. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
  - 2. Provide test reports:
    - a. Provide certificate listing satisfactory results for pressure tests.
    - b. Provide certificate listing satisfactory results for flushing of systems.
- F. Closeout Submittals:
  - 1. Project Record Documents: Record actual dimensioned locations for buried or inaccessible piping. Show actual cleanout locations and types.
  - 2. Installation, Operation and Maintenance (IO&M) Manuals:
    - a. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
    - b. Provide copies of approved submittal information for inclusion within the project IO&M Manual.
    - c. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, parts listings, and spare parts list.

## 1.5 QUALITY CONTROL

- A. Qualifications: Work shall be performed by workmen usually employed and experienced with the trade.
  - 1. HDPE Joints: Work shall be performed by workmen qualified and experienced in the use of the butt fusion machine used on the project.
- B. Pre-Installation Meetings: Coordinate installation of plumbing systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any plumbing components.
- C. Regulatory Requirements: 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  - 2. Remove damaged or otherwise unacceptable products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.

3. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. See Section 20 00 00 - Mechanical General Requirements for general mechanical warranty requirements.

## PART 2 - PRODUCTS

### 2.1 STORM WATER PIPING (BELOW GROUND ABOVE BASEMENT GRADE)

- A. Cast Iron Pipe: ASTM A 888, CISPI 301 service weight.
- B. Fittings: DWV no-hub Cast iron.
- C. Joints:
  1. Meets ASTM C-1540 standard for heavy duty shielded couplings.
  2. Type 304 stainless steel shield and clamp assembly.
  3. Elastomeric gasket conforming to ASTM C 564.
  4. Sizes 1-1/2" through 4" diameter: 3" wide shield and 4 clamps.
  5. Sizes 5' through 10" diameter: 4" wide shield with 6 clamps.
  6. Manufacturer: Anaco-Husky or equal.

### 2.2 STORM WATER PIPING (BELOW BASEMENT GRADE)

- A. Piping:
  1. HDPE meeting ASTM D13350, PE 3408 resin compound.
  2. Pipe and fittings conforming to standard iron pipe size outside dimensions (IPS), with wall thickness meeting SDR 17, and minimum pressure rating of 100 psi according to ASTM D2837 at 73°F with a service rating of 0.5.
  3. All HDPE pipe shall be from straight sticks of pipe. Under no circumstances shall any coiled HDPE pipe be used to manufacture products furnished under this specification. All core sewer pipe shall be black, stamped with the appropriate SDR and ASTM designations.
- B. Joints: Thermal butt fusion in accordance with ASTM D2657 using a pipe manufacturer approved fusion machine.
- C. Elbows: All core sewer elbows shall be fabricated using sweep bends. Sweep bends shall be seamless, manufactured in one continuous piece of SDR 17 HDPE pipe, with an angular tolerance of  $\pm 2$  degrees without reversion and shall have a bend radius as specified on the drawings with a tolerance of  $\pm 1.0$  inch. The elbows shall not be mitered and fused. All elbows must maintain normal outside diameters along their entire length without tolerance as per ASTM-F714 and be suitable for butt-welding or electrofusion. The outside surface of the elbows shall exhibit all the specified characteristics of the straight pipe and shall not have any blisters or other surface defects from the manufacturing process.
- D. Tees:
  1. Pressure rated to match SDR.
  2. Fittings shall be fabricated to provide sweep radii for bends equal to or greater than cast iron DWV fitting, refer to Section 3 below.
- E. Adaptors: Adaptors between HDPE and Stainless Pipe shall be HDPE pipe to 316 Steel flange.
- F. Manufacturers:
  1. Piping: Phillips Driscopipe, Chevron Plexco or equal.
  2. Fittings: Arctic Insulation and Manufacturing or equal.
  3. PVC Couplings: Harco or equal.

### **2.3 STORM WATER PIPING, ABOVE GROUND**

- A. Cast Iron Pipe: ASTM A74, service weight.
  - 1. Fittings: Cast iron.
  - 2. Joints: ASTM C564, neoprene gasket system.
- B. Cast Iron Pipe: CISPI 301, hubless.
  - 1. Fittings: Cast iron.
  - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. Copper Pipe: ASTM B306, DWV, ASTM B75, ASTM B88, ASTM B251 Type L.
  - 1. Fittings: ASME B16.23 cast bronze, or ASME B16.29 wrought copper.
  - 2. Joints: ASTM B32, solder, Grade 50B.

### **2.4 COUPLINGS FOR HUBLESS CAST IRON STORM DRAINAGE PIPE**

- A. Standard stainless steel band with two clamp bands and elastomeric gasket. Above grade use only.
- B. Cast iron coupling with two (2) or four (4) bolts and elastomeric gasket. If used underground, provide corrosion resistant bolts.
- C. Heavy duty all stainless steel band type coupling with four or more clamp bands.
- D. Manufacturers: Husky, MG Coupling, or equal.

### **2.5 ADAPTERS**

- A. Use to connect pipes of same nominal size but different outside diameter or pipes of different material (cast iron to ductile iron, etc.).
- B. Rigid sleeve type coupling, ductile iron center ring and end rings, elastomeric gaskets, corrosion resistant bolts or polyethylene encasement.
- C. Manufacturers: Romac, or equal.

### **2.6 FLEXIBLE AND EXPANSION COUPLINGS**

- A. Flexible elastomeric or thermoplastic couplings with stainless steel clamp bands.
- B. Manufacturers: Fernco, Tech Specialties, or equal.

### **2.7 CLEANOUTS**

- A. Floor Cleanouts:
  - 1. Cast iron body, bronze plug with neoprene gasket.
  - 2. Adjustable head to match finished floor elevation.
  - 3. Square, scoriated bronze top in areas with square tile patterns. Round, scoriated bronze top in areas with vinyl, concrete or non-square tile.
  - 4. Where indicated, provide cleanout tops with tile-terrazzo insert or carpet insert to match surrounding floor finish.
- B. Wall Cleanouts:
  - 1. Cast iron body, recessed bronze plug.
  - 2. Wall access panel or access cover with center screw.
- C. Yard Cleanouts:
  - 1. Cast iron body, bronze plug with neoprene gasket.
  - 2. Heavy-duty access frame with anchor flanges and secured cover, fully surrounding and independent of cleanout.
- D. Manufacturers: J.R. Smith, Josam, Zurn, MIFAB.

## 2.8 ACCESS DOORS

- A. Provide wall and ceiling mounted access doors in accordance with Section 08 31 00 Access Doors and Panels.

## 2.9 TD-1 - TRENCH DRAIN:

- A. Fixture: Precast glass fiber reinforced polyester interlocking channels with sloped and neutral graded channels, sloped channel bottom slope of 0.6 percent. Accessories to include end plates, connectors, corner connectors, and bracket supports for a complete trench drain system with layout as indicated on drawings.
- B. Outlet locations as shown on drawings. In-line silt box with sediment bucket at each outlet.
- C. Ductile iron rails and grating with integral locking system, ADA compliant galvanized steel mesh grate for Class B load rating (28,100 lbs, 580 psi).
- D. System installed in accordance with manufacturer's instructions.
- E. MEA-Josam Pro-Plus 100.

## 2.10 ROOF DRAINS

- A. (RD-1) Roof Drain:
  - 1. Fifteen inch (15") diameter (nominal), duco cast iron drain body,
  - 2. sump receiver and under-deck clamps
  - 3. Adjustable extension Sleeve.
  - 4. Reversible height adjustment collar, gasket and o-rings.
  - 5. Combined gravel stop and flashing clamp.
  - 6. Polyethylene dome.
  - 7. No hub outlet sized for drain lines shown.
  - 8. Manufacturers:
    - a. J. R. Smith
    - b. Josam
    - c. Pre-approved equal.
- B. (RD-2) Roof Drain:
  - 1. Similar to RD-1 with two inch (2") exterior water dam.

## 2.11 DIRECT INSERTION ELECTRIC HEAT TRACE

- A. Direct insertion type heating: UL listed for the application.
- B. Self-regulating heating cable consisting of two (2) 16 AWG nickel-coated copper bus wires embedded in a self-regulating polymer core that varies its power output to respond to temperature along its length, nominally 5 watts per foot in air and 12 watts per foot in snow/ice. Tinned copper braid around insulation with a protective jacket of a UV resistant polymer suitable for environmental exposure and maximum temperature expected.
- C. Coordinate voltage with Divisions 26 - Electrical.
- D. Manufacturer: Raychem IceStop GM-1X (120V) or equal.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.
- B. Surface Preparation:
  - 1. Verify that excavations are to required grade, dry, and not over-excavated.
  - 2. See Division 2 – Existing Conditions.

### 3.2 INSTALLATION

- A. Locate primary roof drains at low point of flat-profile roofs. Locate secondary roof drains adjacent to primary drains as indicated on drawings. Carefully coordinate with Architectural detailing.
- B. Locate wall cleanouts such that they are immediately accessible from behind a wall access door. Access door must be large enough so that the cleanout plug can be easily removed with standard tools. Drain valve must be located such that a drain hose can be easily connected and removed through the access panel and the applicable riser can be completely drained by gravity to either an area floor drain or five gallon bucket.
- C. Install piping in accordance with manufacturer's instructions.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- G. Where pipe support members are welded to structural building framing; scrape, brush clean, and apply one coat of zinc rich primer to welding.
- H. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish Painting. Refer to Section 09 90 00 – Painting and Coating.
- I. Storm Drainage Piping – Above Ground:
  - 1. Grading: Grade as indicated on drawings or as specified above.
  - 2. Connections:
    - a. Hub and hubless piping joints as specified above for underground piping.
    - b. Thread Joints: Assemble with TFE tape or approved non-hardening joint compound.
    - c. Solder Joints: Assemble with lead free solder unless lead/tin solder is specifically approved in writing. Solder containing lead shall be stored separately from lead free solder and clearly identified for use on drainage pipes only.
    - d. Grooved and other joints: Assemble in accordance with manufacturer instructions.
- J. Storm Drainage Piping – Below Ground:
  - a. Excavate and backfill in accordance with Section 31 20 02 Trenching with class A bedding material.
  - b. Butt fused or electrofusion joining of pipes shall be completed strictly in accordance with manufacturer's instructions.
  - c.
- K. Cleanouts:
  - 1. Provide as indicated on drawings.
  - 2. If field conditions create additional offsets or increase length of piping shown, provide additional cleanouts as required by plumbing code.
  - 3. Where practical or as indicated provide cleanouts on vertical rainwater piping immediately above grade.
- L. Heat Trace:
  - 1. Where insertion type heating cable is used in rainwater and other piping with an open end, secure the end of cable a short distance within the open end of the pipe.
  - 2. Provide fittings as required to convey the cable out of the piping to connect to the electrical source. Penetration shall be made watertight.
  - 3. Protect circuits feeding electric heat trace with GLCB ground fault interrupters. Coordinate with Division 26.

### 3.3 HDPE TEE FITTINGS

- A. All fusion joints in fabricated fittings shall be documented by a computer that records pressure and temperature applied at each fused joint. Computer printouts and electronic data for each fitting shall be made available to the owner upon request. The contractor shall ensure that each joint is fused at the temperature and pressure recommended by the pipe manufacturer in order to achieve the maximum pressure rating for that joint. Submit the computer record for each fitting.
- B. All fittings for each project shall be labeled with a unique identifier that corresponds with the fusion computer printouts for each fitting.
- C. All fabricated fittings shall have all inside fusion beads removed in such a manner as to result in a continuously smooth flow path inside the pipe per the requirements of the International Plumbing Code Section 704.2 and 706.2, and the Alaska Department of Environmental Conservation 18 AAC 72.040(b)(4)(C).

### 3.4 CONSTRUCTION

- A. Interface with Other Work:
  - 1. Review architectural and millwork shop drawings. Confirm location of cleanouts and access panels prior to installation.
  - 2. Fully coordinate and sequence installation of roof drains and piping with trades responsible for portions of this and other related sections of the Project Manual.
  - 3. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

### 3.5 REPAIR/RESTORATION

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### 3.6 FIELD QUALITY CONTROL

- A. Site Tests:
  - 1. Water Test: Test storm drainage system with water in accordance with the Uniform Plumbing Code.
  - 2. Air Test:
    - a. In general, air testing is not acceptable. In the event of low temperature conditions that would subject system piping to freezing, an equivalent air pressure test may be conducted in accordance with the Uniform Plumbing Code with prior Department's Representative approval.
    - b. Observe necessary safety procedures when testing with air including, but not limited to, use of protective goggles or face shields. Only persons directly involved in testing procedure shall be within 20 feet of a pipe under pressure.
  - 3. Test results shall be certified in writing as required by General Conditions. Include dates and sections tested, test pressure, test duration, printed names and signatures of person performing the test and Department's Representative witnessing the test.
- B. Inspection: Arrange for inspections and provide notice to the Department's Representative when the entire Work, or logical portions thereof, is ready for inspection.

### 3.7 ADJUSTING

- A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.

**3.8 CLEANING**

- A. Clean and flush storm drain piping and roof drains to remove dirt and foreign debris.
- B. Provide written certification which documents that the complete storm drain system has been flushed of foreign debris. Include date and printed names and signatures of person(s) performing the flush and Department's Representative witnessing the flush.

**END OF SECTION 22 14 23**

**SECTION 22 15 13  
COMPRESSED AIR SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. This section describes the compressed air system for the work shop areas.
  - 2. The system includes
    - a. An electric air compressor with reservoir tank,
    - b. Air distribution piping and valves,
    - c. Ceiling mounted hose reel
    - d. Filter-Regulators
    - e. Filter-Regulator-Lubricators
    - f. Quick disconnect couplings

**1.2 RELATED SECTIONS**

- A. 01 91 00 - Commissioning
- B. 13 48 00 - Vibration and Seismic Control
- C. 20 00 00 - Mechanical General Requirements
- D. 20 05 29 - Hangers and Supports
- E. 20 05 53 - Mechanical Identification
- F. 23 05 93 - Testing, Adjusting and Balancing
- G. 23 21 23 - Motors
- H. 25 90 00 - Sequences of Operation

**PART 2 - PRODUCTS**

**2.1 AIR COMPRESSOR AC-1**

- A. Stationary Vertical Air compressor
- B. Provide the following features:
  - 1. Vertical 80 gallon receiver ASME stamped tank with drain valve
  - 2. Maximum 175 psi.
  - 3. ASME rated safety valve.
  - 4. Cast iron twin cylinder compressor, 10,000 hour life.
  - 5. Belt guard.
  - 6. Pressure switch auto/off switch.
  - 7. Motor starting unloader.
  - 8. Pressure gauge.
  - 9. Oil Site gauge
  - 10. Check valve between compressor outlet and tank.
  - 11. Manufacturer's outlet pressure regulator.
  - 12. Manufacturer's vibration isolators.
- C. Motor: 5 HP 460,3Ph with thermal overloads, no starter required.
- D. Provide all miscellaneous controls and wiring for complete and proper operation. Arrange wiring for single point connection by Electrical Contractor.

**2.2 PIPING AND FITTINGS**

- A. Minimum working pressure 150 psig .
- B. Steel Pipe: Schedule 40 black threaded pipe with black malleable iron fittings.

- C. Copper: Type "K" hard drawn copper tubing with wrought copper fitting soldered with silfos.

### **2.3 VALVES**

- A. Minimum working pressure 150 psig W.O.G.
- B. Type: Ball valve with reinforced Teflon seat. Similar to NIBCO T-590-Y.

### **2.4 HOSE REEL**

1. Spring powered open hose reel for compressed air supply with hose, swivel assembly and accessories. Welded gauge plated steel construction with gusset plate reinforcements. Full sized air port connection through reel hub.
2. Working Pressure: 150 psig
3. Dispensing hose: Three Eights (3/8) inch by fifty (50) feet long dispensing hose
4. Adjustable guide-arms to accommodate multiple mounting positions
5. Double pedestal arm hose guides
6. Simple "slide-in" mounting design
7. Non-sparking ratchet assembly
8. External brass swivel housing
9. Repairable guide rollers
10. Heavy duty return-spring
11. Permanently lubricated bearings
12. Audible ratchet lock
13. Multi position roller guide for any mounting position
14. Ball stops for size of hose indicated
15. Provide manufacturers' mounting brackets and mounting channels
16. Metal label for "AIR" with mounting hardware

### **2.5 FILTER-REGULATOR-LUBRICATOR**

- A. Regulator: 1/2 inch standard series, 64 SCFM, 5-0-15 psig adjustment. 160 psig gauge
- B. Filter: Polycarbonate bowl and bowl parts, site glass. Twist drain. Coalescing filter, 5 micron filter element.
- C. Manufacturer: Wilkerson (basis of design), Speedaire, Ingersol-Rand

### **2.6 AIR OUTLET QUICK DISCONNECT COUPLINGS**

- A. Standardize all outlets throughout the project.
- B. Type: Ring and ball lock type.
- C. Manufacturer: Devilbiss, Chicago, Pneumatic Tool, Milwaukee, or approved equal.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Packaged Compressor/Receiver.
  1. Install packaged compressor/receiver unit in accordance with the manufacturer's written installation instructions.
  2. Mount unit to solid floor using pre-manufactured vibration isolation floor mounts.
- B. Piping:
  1. Slope all piping to drain away from the receiver 1/16 inch per foot minimum.
  2. Provide moisture leg and drain cocks at all low points.
  3. Provide flexible connector between compressor and piping.

### **3.2 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Testing:
  - 1. Conduct 150 PSIG air test of all piping for 30 minutes using an approved air testing procedure.
  - 2. Repair leaks and retest as necessary until test pressure is maintained for full duration of the air test.
- C. Inspection:
  - 1. Observe compressor during operational cycle.
  - 2. Verify compressor does not transmit objectionable vibration to surrounding building structure.
  - 3. Verify compressor is properly mounted and deflection is within tolerance as established by the manufacturer.

**END OF SECTION 22 15 13**

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**SECTION 22 40 00  
PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Plumbing Fixtures and Trim.
  - 2. Drinking Fountains.
  - 3. Tempering Valves.
  - 4. Hose Bibbs and Hydrants.
  - 5. Floor Drains.
  - 6. Elevator Sump Pumps.
- B. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- C. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 20 07 00 - Mechanical Insulation
  - 7. 22 11 00 - Domestic Water Piping and Specialties
  - 8. 22 14 00 - Sanitary Waste and Vent Piping
  - 9. 23 05 93 - Testing, Adjusting and Balancing
  - 10. 23 21 23 - Motors
  - 11. 25 90 00 - Sequences of Operation

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. Uniform Plumbing Code (UPC).
- C. ANSI A117.1 - 2003 Accessible and Useable Buildings and Facilities

**1.3 DEFINITIONS**

- A. See the definitions listed in Section 20 00 00 - Mechanical General Requirements.
- B. Handicap, handicapped, ADA compliant: Refers to fixtures that comply with the requirements of ANSI A117.1.

**1.4 SUBMITTALS**

- A. Product Data:
  - 1. Provide manufacturers catalog information for each fixture.
  - 2. Provide plumbing specialty component sizes, rough-in requirements, service sizes, and finishes.
  - 3. Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- B. Shop Drawings: Refer to Sections 22 11 00 - Domestic Water Piping and Specialties and 22 14 00 - Sanitary Waste and Vent Piping for shop drawing requirements showing plumbing fixtures.

- C. Operation and Maintenance Manual: Include manufacturers' descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.
- D. Closeout Submittals:
  - 1. Project Record Documents: Record actual location and label each fixture.
  - 2. Operation Data: Indicate frequency of treatment required for interceptors.
  - 3. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views for specialties and fixtures.
  - 4. Site testing documentation.
  - 5. Manufacturer warranties.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  - 1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
  - 2. Acceptable Installers: Work shall be performed by workmen usually employed and experienced with the trade.
- B. Pre-Installation Meetings: Coordinate the installation of systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any system components.
- C. Regulatory Requirements: 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.
  - 4. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. See to Section 20 00 00 - Mechanical General Requirements, for general mechanical warranty requirements.
- B. Provide manufacturer warranties for products provided under this Section.
- C. Submit manufacturer's warranty and ensure forms have been completed in Department's name and registered with manufacturer.

## PART 2 - PRODUCTS

### 2.1 FIXTURES

- A. Traps, Stops and Supplies:
  - 1. Provide traps, stops and supplies for fixtures.
  - 2. P-Traps: 17 gauge chrome-plated tubular brass or cast brass.
  - 3. Supplies: Flexible, stainless steel.

4. Stops: Quarter-turn, removable key type. Commercial quality metal components only; no plastic parts.
- B. Flush Valves:
  1. Manufacturer: Sloan, Zurn, or approved equal.
- C. Lavatory Faucets:
  1. Manufacturer: Delta, Chicago Faucets, or approved equal.
- D. Carriers:
  1. Manufacturer: J.R. Smith, Josam, Zurn, MIFAB.
  2. Provide carriers for wall mounted fixtures.
- E. Fixtures specified elsewhere, or otherwise furnished:
  1. Provide appropriate strainer, tailpiece, trap, waste and supplies.
  2. Rough in and connect only.
- F. Handicapped Fixtures:
  1. Provide fixtures in compliance with the appropriate standard listed in Part 1.
  2. Provide fixtures operable with one hand without grasping, pinching or twisting of the wrist, and requiring not more than five pounds of operating force.
  3. Handicap accessible lavatories and sinks: Where piping is exposed, provide fixture insulation assembly. Refer to Section 20 07 00 - Mechanical Insulation.
- G. Sensors operated fixtures: In addition to features described in the Fixture list, provide the following features:
  1. General:
    - a. Provide with Infra-red sensors, solid state circuitry, 24 VDC operation.
    - b. Provide low voltage transformers. Battery operated fixtures not allowed.
    - c. Adjustable sensor range, variable time-out adjustment.
    - d. Filtered solenoid valves.
  2. Hand faucet:
    - a. ADA compliant.
    - b. Splash proof electronic circuitry.
    - c. Aerator/spray head with pressure compensating flow control.
    - d. Trim plate for 4-inch center-set sink.
    - e. Under-counter control module.
  3. Manufacturer: Delta, Sloan, Zurn, Symmons.

## 2.2 FIXTURE LIST

- A. P-1, - Water Closet:
  1. Fixture:
    - a. Wall hung, siphon jet,
    - b. elongated bowl,
    - c. low consumption (1.6 gpf), High Efficiency Toilet rated,
    - d. Permanent EverClean surface.,
    - e. 1-1/2 inch top spud. American Standard model AFWall EL 1.6.
  2. Flush Valve: Sloan Royal model 111.
  3. Seat: Open front, commercial weight, heavy duty, solid plastic, stainless steel check hinge, without cover, white.
  4. Carrier: Floor mounted. No residential.
- B. P-1H - Water Closet:
  1. Same as Fixture P-1 except ADA: ADA compliant. Handicapped mounting height.
- C. P-2 - Urinal:
  1. Fixture: Siphon jet, vitreous china, low consumption (1.0 gpf). Integral flush rim, wall hangers, 3/4 inch top spud. American Standard model Trimbrook 1.0.
  2. Flush valve: Sloan Royal model 186-1.0.

3. Carrier: Floor mounted. No residential.
- D. P-2H - Urinal:
  1. Same as P-2 except ADA: ADA compliant. Handicapped mounting height.
- E. P-3H - Counter Lavatory:
  1. Fixture: Furnished under Architectural.
  2. Faucet: Single lever, deck mounted. Delta model 501-WF.
  3. Drain: Metal grid strainer.
  4. ADA: ADA compliant. Offset tailpiece as necessary for handicapped access.
- F. P-3HS - Counter Lavatory:
  1. Fixture: Furnished under Architectural.
  2. Faucet: Basis of Design: Delta sensor operated faucet, with thermostatic mixing valve conforming to ASSE 1070.
  3. Drain: Metal grid strainer.
  4. ADA: ADA compliant. Offset tailpiece as necessary for handicapped access.
- G. P-4H - Single Compartment Sink:
  1. Fixture:
    - a. Single compartment, 18 gauge, type 304 stainless steel,
    - b. 19 inch by 16 inch by 6-1/2 inch deep, self rimming, sound deadened,
    - c. Center rear drain location with
    - d. J-35 strainer.
    - e. Just Manufacturing model SL-ADA-2122-A-GR.
  2. Faucet:
    - a. 4" centers
    - b. 6" heavy duty goose neck spout,
    - c. 4" blade handles
    - d. 1.5 GPM flow control Aerator
    - e. Delta Teck Series model 27C4944
  3. ADA: ADA compliant. Pipe drain for handicapped access.
- H. P-5H - Single Compartment Sink:
  1. Fixture:
    - a. Single compartment, 18 gauge, type 304 stainless steel,
    - b. 19 inch by 16 inch by 6-1/2 inch deep,
    - c. self rimming, sound deadened,
    - d. Center rear drain with
    - e. J-35 strainer.
    - f. Deck punching for single hole center mount faucet and hot water dispenser on right.
    - g. Just Manufacturing model SL-ADA-2122-A-GR.
  2. Faucet:
    - a. Single handle center mount faucet, single hole
    - b. 8" high by 9" long spout with pull out spray handle connected to valve body with flexible hose having minimum 34" usable length.
    - c. Lever handle that returns to neutral position when faucet is turned off.
    - d. Integral supply check.
    - e. Delta model 470-DST,
  3. Hot water dispenser:
    - a. Hot water only dispenser
    - b. UL listed, 120 V, 750 watts, 6.25 amps.
    - c. 60 cups per hour of 190 Deg water.
    - d. 2/3 gallon tank, adjustable 160 Deg to 200 Deg thermostat factory set to 200 Deg F.
    - e. Self closing valve.
    - f. Thermally insulated.
    - g. In-Sink-Erator Model H-770.
  4. ADA: ADA compliant. Pipe drain for handicapped access.

- I. P-6H - Double Compartment Sink:
  - 1. Fixture:
    - a. Double compartment, 18 gauge, type 304 stainless steel sound deadened,
    - b. Each compartment 14 inch by 16 inch by 6-1/2 inch deep, self rimming,
    - c. Center rear drain for each bowl
    - d. J-35 strainer.
    - e. Just Manufacturing model SL-ADA-2133-A-GR.
  - 2. Faucet:
    - a. Single handle center mount faucet, three hole
    - b. 8" high by 9" long spout with pull out spray handle connected to valve body with flexible hose having minimum 34" usable length.
    - c. Lever handle that returns to neutral position when faucet is turned off.
    - d. Integral supply check.
    - e. Delta model 470-DST,
  - 3. Hot water dispenser:
    - a. Hot water only dispenser
    - b. UL listed, 120 V, 750 watts, 6.25 amps.
    - c. 60 cups per hour of 190 Deg water.
    - d. 2/3 gallon tank, adjustable 160 Deg to 200 Deg thermostat factory set to 200 Deg F.
    - e. Self closing valve.
    - f. Thermally insulated.
    - g. In-Sink-Erator Model H-770.
  - 4. Disposer:
    - a. 3/4 HP, 120 V, 1PH, 1725 RPM, 8.1 a motor, manual overload
    - b. Stainless steel grind chamber, 2 stage grinder,
    - c. Anti vibration mount, antivibration tailpiece mount, quiet collar sink baffle, sound insulation
    - d. 1-1/2" drain outlet, dishwasher connection.
    - e. In-sink-erator model Evolution Essential.
  - 5. ADA: ADA compliant. Pipe drain for handicapped access.
- J. P-7 - Mop Sink:
  - 1. Fixture:
    - a. 24 inch by 24 inch with 10 inch high walls.
    - b. 304 Stainless Rim Guards, one for each exposed rim.
    - c. Stainless steel drain body, 18 ga. Stainless grid strainer,
  - 2. Accessories:
    - a. Manufacturer's faucet with hot and cold water valves, vacuum breaker, hose thread outlet, bucket hook, wall brace.
    - b. 5/8" x 5' hose with coupler to faucet, wall clamp.
    - c. Mop wall hanger with 3 mop clamps.
    - d. 12" high stainless wall panels, one for each side along a wall.
  - 3. Basis of Design: Florestone Model MSR-2424
- K. P-8 - Service Sink:
  - 1. Fixture:
    - a. Floor mounted, single compartment, enameled cast iron. 24 inch by 21 inch by 10-1/2 inch deep.
    - b. 3" trap standard and strainer with floor mounting, floor flange, cleanout plug.
    - c. Two faucet holes located on integral backsplash, on eight inch centers.
    - d. American standard Akron.
  - 2. Faucet: Delta Teck series 28C2383, with integral vacuum breaker, hose thread end, 3 inch lever blade handles.
  - 3. Drain Connector: Cast iron No-hub adaptor. Mifab MI-850 or equal.

- L. P-9 - Shower System
  - 1. Fixture:
    - a. 36 inch by 36 inch ID, preformed fiberglass construction, left hand, single threshold
    - b. grab bars, fold-down seat, low profile bottom for ADA compliance, recessed soap dish, anti-slip floor, curtain rod.
    - c. Fiberfab 40H1KDLP.
  - 2. Shower head:
    - a. Hand held shower, fixed full body spray,
    - b. 36 inch slide bar, 69 inch spiral metal hose, 90 degree wall supply elbow.
    - c. Delta model RPW336HDF.
  - 3. Mixing valve:
    - a. Valve only trim, adjustable rotational limit stop, pressure balanced single handle mixing valve, 2.5 GPM. Delta model T13020.
  - 4. ADA: ADA compliant.
- M. EWS-1 - Emergency Shower and Eyewash:
  - 1. Recessed barrier-free safety station combination eye/facewash and shower.
  - 2. Shower:
    - a. Wall-mounted 10 inch diameter stainless steel shower head.
    - b. 1" IPS nipple and fittings for horizontal shower supply, exposed pipe and fittings brushed stainless steel
  - 3. Recessed 16 ga stainless steel wall cabinet with 3-1/2" wall depth to house
    - a. Pull down eye/face wash section with adjustable eye/face wash spray heads with integral adjustable flow control and strainer, drain pan, 2" drain fitting. Flow starts when section is pulled open.
    - b. Stay-open ball valves operated by a stainless steel panic bar actuator for shower
    - c. Tempered water line connection.
  - 4. ADA: ADA compliant.
  - 5. Basis of design: Guardian GBF2170

### 2.3 DRINKING FOUNTAINS

- A. DF-1H - Drinking Fountain:
  - 1. Fixture: Wall mounted, dual height,
  - 2. Satin finish 18 gauge type 304 stainless steel, back panel with matching finish,
  - 3. Polished chrome hooded stream projector with push-button controls,
  - 4. Front-accessible cartridge and flow adjustment, ,
  - 5. ADA cane touch skirt in satin finish stainless steel to match fixture. Haws 1011 or approved equal.
  - 6. Carrier: Wall mounted. No residential.
  - 7. ADA: ADA compliant.
  - 8. Basis of Design: Haws 1011

### 2.4 HOSE BIBBS AND HYDRANTS

- A. HB-1 - Wall hydrant:
  - 1. Box type, Automatic draining, freezeless, with integral vacuum breaker.
  - 2. Flush mounted, with key operated hinged cover.
  - 3. 3/4 inch hose connection.
  - 4. Woodford model B65 or Acorn model 8151.
- B. Manufacturers:
  - 1. MIFAB.
  - 2. Woodford.
  - 3. Acorn.

## 2.5 TEMPERING VALVES

- A. TV-1 - Thermostatic Tempering Valve:
  - 1. For use with multiple combination emergency shower/eyewash stations (EWS-1).
  - 2. Performance:
    - a. Blending temperature: 85 Degrees F (factory set).
    - b. High temperature limit stop: 90 Degrees F (adjustable).
    - c. Flow range: 1 to 31 GPM.
    - d. Hot water failure bypass mode.
  - 3. Connections:
    - a. 1-inch CW and 1-inch HW supply with integral strainer check and stop valves.
    - b. 1-1/4-inch tempered water (TW) outlet connection.
  - 4. Accessories:
    - a. Tempered water temperature gauge.
    - b. Mounting bracket.
  - 5. Manufacturer:
    - a. HAWS, Model: 9201H
    - b. Approved equal.
  
- B. TV-2 - Thermostatic Tempering Valve.
  - 1. Separate high and low capacity thermostatic mixing valves, pressure regulating valve, integral check stops, supply and outlet pressure gauges.
  - 2. Lead-free construction.
  - 3. Rough bronze finish.
  - 4. Minimum flow .5 GPM
  - 5. Maximum pressure drop at 31 GPM: 10 psi.
  - 6. Powers model LFMM431HLAEM0.

## 2.6 FLOOR DRAINS

- A. FD-1 - Floor Drain:
  - 1. Fixture: Duco Cast iron body with flashing collar,
  - 2. Adjustable strainer head with polished 6" bronze strainer. No-hub outlet,
  - 3. No hub outlet as scheduled.
  - 4. Trap primer connection.
  - 5. J.R. Smith No. 2005
  
- B. FD-2 - Floor Drain:
  - 1. Cast iron similar to FD-1 except with 8" round top.
  
- C. FD-3 - Floor Drain:
  - 1. Fixture: Medium duty, Duco cast iron body with flashing collar,
  - 2. Adjustable top and 8-inch round top tractor grate.
  - 3. No-hub outlet sized as scheduled.
  - 4. J.R. Smith No. 2320.
  
- D. FS-1 - Floor Sink:
  - 1. Fixture: Cast iron, 8-1/2 inch x 8-1/2 inch top, flanged receptor with acid resistant coated interior, nickel bronze rim. Dome bottom strainer. No-hub outlet.
  - 2. Grate: 1/2-inch nickel bronze grate.
  - 3. Trap primer connection.
  - 4. No-hub outlet sized as scheduled.
  - 5. J.R. Smith 3100.
  
- E. FS-2
  - 1. Duco Fabricated Steel, 24 x 12 top extra large receptor, 17" deep.
  - 2. Nickel bronze rim with 1/2 grate.
  - 3. No-hub outlet sized as scheduled.

4. J.R. Smith 3250
- F. TD-1 Trench Drain
  1. Pre-engineered trench drain system.
  2. Constructed with glass fiber reinforced polyester pressed from sheet molding compound of polyester resin, mineral fillers and glass fiber mats.
  3. 4" wide internal drain sections sloped to drain.
  4. Grating: Load class C, Stainless Steel Mesh, ADA compliant.
  5. Grating locking system that does not require tools to secure or remove grating.
  6. Silt box sections which integrate as a section of trench with sump and drain connections sized for connecting drainage piping as shown.
  7. Accessories as necessary for a complete installation, including end caps, corner and tee connectors, bracket with wedge and bracket supports.
  8. Basis of Design: MEA-Josam Pro-plus 100.
- G. Manufacturers: Josam, J.R. Smith, Zurn, MIFAB.

## 2.7 ELEVATOR SUMP PUMPS

- A. Provide packaged submersible pump, water/oil sensing and control system designed for the automatic pumping of water while preventing the pumping of oil.
- B. Main control unit, junction box, pump, floats and sensor factory assembled and tested as a complete, ready-to-use system approved by a nationally recognized testing laboratory.
- C. Sump Pump:
  1. Approved to UL 778 standards.
  2. Fully submersible type.
  3. Type 304 stainless steel construction with Intake stand.
  4. 70 GPM at 35 FT W.C.
  5. Thermal and overload protection.
  6. Rated for both continuously and intermittent operation.
  7. Motor: 1/2 HP, 115 VAC, 1 Phase.
  8. Pump discharge check valve.
- D. Packaged Control System:
  1. Control Panel:
    - a. NEMA 4X enclosure with viewing window.
    - b. Separate LED status indicators for power available, pump running, oil fault, high water level, motor overload.
    - c. Probe sensitivity adjustment.
    - d. Pump overload setting adjustment.
    - e. Audible alarm with silence and reset buttons.
    - f. Remote relay connection.
    - g. Multi-pin receptacle.
    - h. Power cord.
  2. Pump Accessories: Manufacturers Check Valve
  3. Junction Box:
    - a. NEMA 4X enclosure.
    - b. Multi-pin receptacles for pump power and multi-sensor connection.
    - c. Multi-pin connector cable.
  4. Sensors:
    - a. Self-cleaning stainless steel oil sensor probe.
    - b. High level alarm float.
    - c. Pump "ON" float.
    - d. Sensor cabling.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Confirm location and size of fixtures and openings before piping rough-in and installation.
- B. Verify that rough-ins have been provided, are correctly sized and are located within dimensional tolerances for fixtures to be installed prior to installation of fixtures.
- C. Interface with other Work: Review Architectural drawings and millwork shop drawings to verify correct fixture locations.

#### **3.2 INSTALLATION**

- A. Install fixtures in accordance with manufacturer's instructions.
- B. Provide permanent metal and wire positioners, supports and carriers to secure fixtures and piping rigidly in proper alignment without sway or sideplay.
- C. Anchor fixtures securely to withstand applied vertical load of not less than 250 pounds on the front of the fixture, without noticeable movement.
- D. Install fixtures plumb, level and to the finished architectural surface, so that the maximum gap between the fixture and the surface does not exceed 3/16 inch. Caulk the edge of the joint between fixture and surface with silicone or butyl type waterproof caulking compound.
- E. Install and connect hot water on left and cold water on right, as viewed when facing the fixture.
- F. Locate flush valve handles on handicapped accessible water closets on the wide side of the stall. Mount Accessible fixtures shown in the ADA guidelines to the heights indicated.

#### **3.3 ADJUSTING**

- A. Adjust functional components for proper operation in accordance with manufacturers' recommendations, or as otherwise directed.
- B. Adjust each emergency eye/face wash spray head to 2-1/2" gpm.

#### **3.4 CLEANING**

- A. Clean fixtures and trim to a spotlessly clean condition. Obtain a written certification from the Department that this has been accomplished.

**END OF SECTION 22 40 00**

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**SECTION 23 05 93**  
**TESTING, ADJUSTING AND BALANCING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. General requirements and methods of execution relating to the testing and balancing of the mechanical systems provided on this project.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 22 11 00 - Domestic Water Piping and Specialties
  - 4. 22 15 13 - Compressed Air Systems
  - 5. 23 05 93 - Testing, Adjusting and Balancing
  - 6. 23 21 13 - Hydronic Piping and Specialties
  - 7. 23 21 14 - HVAC Pumps
  - 8. 23 21 23 - Motors
  - 9. 23 31 00 - Ducts and Accessories
  - 10. 23 34 00 - Fans
  - 11. 23 35 00 - Industrial Ventilation Systems
  - 12. 23 36 00 - Air Terminal Units
  - 13. 23 36 16 - Laboratory Ventilation Systems
  - 14. 23 37 00 - Air Outlets and Inlets
  - 15. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 16. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 17. 23 56 00 - Refrigerant Condensing Units
  - 18. 23 70 00 - Central Air Handling Units
  - 19. 23 81 00 - Storage Vault HVAC Equipment
  - 20. 23 81 16 - Room Air-Conditioning Units
  - 21. 23 82 00 - Terminal Heating and Cooling Units
  - 22. 23 83 00 - Radiant Floor Heating Equipment
  - 23. 23 83 01 - Snow Melting Equipment
  - 24. 23 84 00 - Humidification Equipment
  - 25. 25 09 00 - Sequences of Operation
  - 26. 25 50 00 - Building Automation and Control
  - 27. 25 55 00 - Variable Speed Drives

**1.2 REFERENCES**

- A. American Air Balance Council (AABC) – National Standards for Total System Balance.
- B. National Environmental Balancing Bureau (NEBB) – Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
- C. National Environmental Balancing Bureau (NEBB) – Testing, Adjusting, Balancing Manual for Technicians.
- D. ASHRAE Standard 111 – Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- E. SMACNA – HVAC SYSTEMS Testing, Adjusting, and Balancing.
- F. AMCA Publication 203, Field Performance Measurements.
- G. AMCA Standard 300-67, Test Code for Sound Rating.
- H. Air Diffusion Council (ADC) – Test Code for Grilles, Registers, and Diffusers.

### 1.3 DESCRIPTION

- A. Furnish the services of a qualified and approved Testing and Balancing Agency to perform the work of this specification section.
- B. The work of this section includes but is not necessarily limited to:
  - 1. Test and balance supply, exhaust and relief ventilating systems.
  - 2. Test and balance specialized laboratory zone differential pressure control in accordance with system pressure maps.
  - 3. Test and balance hydronic heating and cooling systems.
  - 4. Test and balance domestic/laboratory hot water recirculation flow rate.
  - 5. Test and balance emergency shower/eyewash tempered water recirculation flow rate.
  - 6. Test and balance emergency shower/eyewash spray head flow rates.
  - 7. Test and balance specialized laboratory equipment to include fume hoods, snorkels exhausts, hoods and other specialty laboratory equipment with exhaust connections.
  - 8. Test and balance shop Compressed Air Systems.
  - 9. Work directly with the BAS subcontractor to obtain proper system adjustments.
  - 10. Measure room sound power levels and plot NC curves as directed by the Department's Representative..
  - 11. Sign-off PC/FC checklists for Testing, Adjusting and Balancing of mechanical and laboratory systems and equipment as work is satisfactorily completed.
  - 12. Provide a final written Testing, Adjusting and Balancing (TAB) Report which thoroughly documents the requirements of this Section. TAB report to include set point and balance adjustments made during Commissioning.

### 1.4 SUBMITTALS

- A. Balancing subcontractor qualifications. Submit name and qualifications of Balancing Agency for approval with general product Submittals required by section 20 00 00 – Mechanical General Provisions. Submit copy of NEBB certification.
- B. Prior to commencing work, submit sample report forms and outlines indicating adjusting, balancing, and equipment data required.
- C. Testing, Adjusting and Balancing (TAB) Report:
  - 1. Submit a complete report of the testing and balancing of all devices in a format equivalent to that shown in the SMACNA HVAC Systems Testing, Adjusting and Balancing manual. Compile the test data and submit eight copies of the complete test data for forwarding to the Department's Representative for acceptance and/or analysis and recommendations.
  - 2. Report Cover Sheet. Include the following data:
    - a. Project Name.
    - b. Project Address.
    - c. Names of Department's Representative and Engineer.
    - d. Names of General Contractor and HVAC Contractor.
    - e. Report date.
    - f. Names of TAB technicians responsible for the measurements and report.
  - 3. System Review Sheet:
    - a. List systems balanced. Highlight systems found to be performing outside design tolerances.
    - b. Include a summary of problems encountered, deviations from design and deficiencies in performance, remaining problems, recommendations, and comments.
  - 4. Instrument Calibration Report:
    - a. Include a complete list of test equipment used, including apparatus manufacturer's name, model number, serial number, and date last calibrated.
    - b. List the instruments used on the project during the balancing work, on an NEBB "Instrument Calibration Report" form, or equivalent form. This includes flow measuring hoods and other related devices.

5. Air Systems Report. Prepare a report for each air system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:
    - a. System Diagram: Include locations of Air Terminal Units and pitot tube traverses. Include appropriate notes, static pressure reading locations, etc., taken during testing and balancing.
    - b. Air Apparatus or Fan Test Report: Include pertinent data on the test report forms. If test data could not be measured, or is not applicable, indicate such on report forms. List how each actual cfm measurement was obtained (duct traverse, total of outlet airflows, or a combination).
    - c. Duct Pitot Tube Traverse Reports: Include actual temperature and pressure readings recorded at the time of testing and balancing.
    - d. Air Outlet Test Reports: Include applicable  $A_k$  factors and terminal device sizes. If flow measuring hoods are used, indicate their use in the remarks column.
    - e. Include complete identification of elements. Identify by box number, room name and number, air outlet symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.
  6. Hydronic Heating and Cooling System Reports: Prepare a report for each hydronic system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:
    - a. Schematic Diagram: Include heat exchange equipment and locations of flow measuring devices.
    - b. Pump Test Report: Confirm test data was recorded and properly entered on form. Attach manufacturer's pump capacity curves, with the actual pump operating point plotted, to the test report form. List how the actual pump flow rate was determined (flow meter, pump curve, etc.).
    - c. Primary Heat Exchange Equipment: Confirm that appropriate test data has been recorded for the boilers, heat exchangers, chillers, and other primary heat exchange equipment. List how the actual flow rate(s) of each item was determined.
    - d. Terminal Heat Exchange Equipment: Confirm that heating coil and terminal unit temperatures and pressures were recorded and properly entered on form. List how each terminal unit flow rate was determined.
    - e. Include complete identification of elements. Identify by equipment tag number, room name and number, baseboard symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.
  7. Include set of reduced size drawings with air outlets and equipment identified to correspond with data sheets. Record actual locations of thermostats, flow measuring stations, and balancing valves with settings.
  8. Provide report in soft cover, letter size, comb bound binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include drawings within report.
- D. Quality Control/Control Submittals:
1. Pre-functional Installation (PC) and Functional Performance Test (FC) Checklists in accordance with Section 01 91 00 – Commissioning.

## 1.5 QUALITY CONTROL

- A. Qualifications:
1. The work describe in this section shall be performed by a firm certified by the National Environmental Balancing Bureau (NEBB) for air and hydronic balancing.
  2. Maintain a complete service organization that has operated within Alaska for at least three years prior to bid date of this project. Demonstrate satisfactory completion of five projects of similar size and scope in the State of Alaska. Provide references if requested.
  3. Bids by suppliers, Contractors or any firm whose principal business is not that of balancing HVAC systems are not acceptable.

- B. Balancing Standards:
  - 1. Perform total system balance in accordance with NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
  - 2. Maintain one (1) copy of balancing procedural document on site.
  - 3. Use standard NEBB forms.
- C. Pre-Balancing Meeting:
  - 1. Schedule a pre-balancing meeting one week prior to commencing work of this Section, under provisions of Section 01 31 19 – Meetings.
- D. Timing of Work:
  - 1. Do not begin balancing and testing until the systems are complete and in full working order.
  - 2. Schedule the testing and balancing work in cooperation with other trades.
  - 3. Complete the testing and balancing before the date of final project completion.
- E. The Contractor's Responsibility to the Balancing Agency:
  - 1. Award the test and balance contract to the approved agency upon receipt of contract to allow the Balancing Agency to schedule this work in cooperation with other trades involved and comply with completion date.
  - 2. Provide or make available to the Balancing Agency a copy of the approved mechanical, electrical, and control system shop drawings and Submittals.
  - 3. Put heating, ventilating, and air conditioning systems, equipment, and controls into full operation for the Balancing Agency and continue the operation of same during each working day of testing and balancing.
  - 4. Provide scaffolding, ladders, and access to each system as necessary for proper testing and balancing.
  - 5. Make changes in sheaves, belts and dampers, or add any dampers, as required for correct balance as recommended by the Balancing Agency, at no additional cost to the Department's Representative.

## **1.6 SEQUENCING**

- A. Sequence work to commence after completion of systems installation. Schedule completion of testing and balancing before Substantial Completion of Project.

## **PART 2 - PRODUCTS – NOT USED**

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that systems are complete, clean and operable before commencing work. Report defects and deficiencies noted during performance of services that prevents system balance. Beginning of work means acceptance of existing conditions.

### **3.2 PREPARATION**

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Department's Representative to facilitate spot checks during testing.
- B. Provide additional balancing devices as required.

### **3.3 INSTRUMENTATION**

- A. Use instrumentation in accordance with NEBB requirements, calibrated to the accuracy standards specified by this organization.
- B. Flow measuring hoods will be acceptable for measurement of ceiling diffuser performance if calibration accuracy data is provided with the balancing report.

- C. Upon request, make available to the Department's Representative copies of current calibration certificates.

### 3.4 FIELD QUALITY CONTROL

- A. Document each TAB step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### 3.5 ADJUSTING

- A. General:
  - 1. Accurately record measurement data and observed conditions.
  - 2. Permanently/neatly mark valve, damper and other adjustment devices allowing settings to be restored. Set and lock memory stops.
  - 3. After final system adjustments, re-measure flow rates to verify system balance.
  - 4. Leave systems in proper working order to include but not limited to:
    - a. Replace fan belt guards.
    - b. Close and secure access doors and panels.
    - c. Close electrical switch boxes.
    - d. Restore thermostats to specified settings.
    - e. Manually overridden equipment to controlled operation.
    - f. Install duct plugs in duct and cabinets holes used for duct traverse measurements.
  - 5. During substantial and final completion inspections, recheck random selections of data recorded in TAB report as selected and to be witnessed by the Department's Representative.
- B. General Ventilation Systems:
  - 1. Adjust air handling unit/fan air flow volumes (CFM) to within plus or minus 5 percent of design.
  - 2. Adjust ductwork static pressure set points (VSD systems) to provide the scheduled CFM at the critical terminal unit in each ductwork system.
  - 3. Adjust total air outlet flow volume (CFM) to within plus or minus 5 percent of design to each controlled zone.
  - 4. Adjust individual outlets and inlets in each zone to within plus or minus 5 percent of design. Ratio the air flow volumes between air outlets as indicated.
- C. Laboratory Ventilation Systems:
  - 1. Adjust laboratory supply and exhaust system air flow volumes (CFM) to within plus or minus 5 percent of design.
  - 2. Adjust total air outlet flow volume (CFM) to within plus or minus 5 percent of design to each controlled zone.
  - 3. Adjust individual outlets and inlets in each zone to within plus or minus 5 percent of design. Ratio the air flow volumes between air outlets as indicated.
  - 4. Adjust supply air offsets to maintain the differential pressures and air flow directions between zones in accordance with pressure maps. Verify air flow direction indicators are functioning properly where installed. See pressure map drawings M401 and M402.
  - 5. Adjust supply and exhaust ductwork static pressure set points to provide the scheduled supply/exhaust CFM at the critical terminal VAV and EAV terminal units in each ductwork system.
- D. Laboratory Equipment:
  - 1. Adjust fume hoods (100 FPM + 20 CFM sash velocity), snorkels and other laboratory equipment with exhaust ventilation requirements in accordance with the manufacturers written installation and operating instructions and as directed by the equipment manufacturers field startup representative.
- E. Hydronic Heating and Cooling Systems:
  - 1. Adjust pump flow volumes (GPM) to within plus or minus 10 percent of design.

2. Adjust hydronic system static pressure set points (VSD systems) to provide the scheduled GPM at the critical terminal heating element in each hydronic loop.
  3. Verify (with differential pressure gauge) terminal unit automatic flow control valves are operating with supply pressures which are within the installed spring pressure control range for proper operation.
- F. Plumbing Systems:
1. Adjust domestic and non-potable hot water recirculation balance valves to the flow rates as shown not to exceed a flow velocity of 3 FPS or a flow rate of 5 GPM.
  2. Adjust domestic water booster system discharge pressure to provide 15 PSIG at the most remote plumbing fixture.
- G. Compressed Air Systems:
1. Adjust shop compressed air discharge pressure regulators as directed by the manufacturer's written installation and operating instructions and the inlet pressure requirements of the end use equipment.

### **3.6 COMMISSIONING**

- A. Assist the Commissioning Authority throughout the field Commissioning process as required to demonstrate the proper adjustment, balance and operation of mechanical and laboratory equipment.

**END OF SECTION 23 05 93**

**SECTION 23 11 13**  
**FUEL OIL PIPING AND SPECIALTIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Fuel Piping, Fittings and Accessories.
  - 2. Fuel Transfer Pumps.
  - 3. Packaged Daytank.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 13 23 - Aboveground Storage Tanks
  - 7. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 8. 25 09 00 - Sequences of Operation
  - 9. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. International Fire Code (IFC).
- C. National Fire Protection Association (NFPA) Standards:
  - 1. NFPA 30 – 2003: Flammable and Combustible Liquids Code
  - 2. NFPA 31 – 2001: Installation of Oil Burning Equipment.

**1.3 SYSTEM DESCRIPTION**

- A. The work includes provision of the fuel oil distribution system from the main fuel storage tank connections to the day tank, and from the day tank to the oil burning apparatus connections. In general, oil burning equipment is specified elsewhere.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
- C. Shop Drawings:
  - 1. Provide scaled shop drawings which incorporate the following installation information:
    - a. Storage tank, daytank and fuel burning equipment locations and pipe connection points.
    - b. Fuel pipe routing, elevations and slope to drain indication.
    - c. Fuel piping isolation valves and accessory locations.
- D. Quality Control/Control Submittals:
  - 1. Design Data, Test Reports:
    - a. Field test reports.

2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
  - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
    - 1). Printed names and signatures of the installers.
    - 2). Documentation from Manufacturer's representative and Contracting Authority that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
    - 3). Include with the checklist a list of applicable programmable control setpoints with their current programmed settings.
- E. Installation, Operation and Maintenance (IO&M) Manuals:
  1. Provide copies of approved submittal information for inclusion within the project O&M Manual.
  2. Refer to Section 20 00 00 – Mechanical General Requirements, for O&M Manual formatting requirements and number of copies required.

## 1.5 QUALITY CONTROL

- A. Pre-Installation Meetings:
  1. Fully coordinate installation of fuel system components with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any fuel system components.
- B. Regulatory Requirements:
  1. 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. Acceptance at Site:
  1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
- B. Storage and Protection:
  1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

## 1.7 WARRANTY

- A. See to Section 20 00 00 for general mechanical warranty requirements.
- B. Provide manufacturer's warranty for products provided under this section.

## PART 2 - PRODUCTS

### 2.1 FUEL PIPING AND FITTINGS

- A. Above grade:
  1. Carbon Steel Product Line Pipe and Fittings:
    - a. Schedule 40 black steel.
    - b. 3000 lb forged steel socket weld or schedule 40 butt weld fittings.
  2. Copper Product Line Pipe and Fittings:
    - a. Type "K" hard drawn copper with brazed fittings (1,000 degrees F minimum filler metal melting point).
    - b. Type "K" annealed tubing with Swagelok® "Flare" fittings or approved equal.

B. Buried

1. Double-Walled Flexible Product Line Piping Systems:
  - a. Description: UL listed pre-engineered system for underground transfer of flammable liquids. The double-walled piping system shall consist of flexible inner primary pipes contained within a flexible outer secondary containment pipe. Piping runs shall be continuous with no fittings or piping connections, for either the primary or secondary containment pipe, buried below grade. The secondary containment system shall provide water tight containment of the primary piping.
  - b. Product compatibility: Components of the double-wall piping system shall be compatible with No. 1 and No. 2 fuel oil.
  - c. Corrosion resistance: Components of the double-wall piping system shall be made of noncorrosive materials, or if metallic, such as fittings and couplings, isolated from corrosion causing elements.
  - d. Monitoring capability: The design of the secondary containment system shall permit any leak in the primary piping system to flow from its source to the AST-1 base pad accessible leak detection sump which shall be fitted with an electronic leak detection system.
  - e. Manufacturer: OPW FlexWorks or approved equal.

**2.2 TRANSITION SUMPS**

- A. Provide one-piece polyethylene transition sumps for AST-1 above ground piping transition to below ground piping system and for shallow bury intermediate leak detection sumps. Compatible with buried fuel transfer piping system
- B. Manufacturer: OPW TSS Series or approved equal.

**2.3 TRACER TAPE:**

- A. Underground tracer tape shall be a minimum of 6 inches wide and labeled, "CAUTION - BURIED FUEL LINE BELOW." Provide tracer tape for buried piping, except under building slabs. Tape shall be a maximum of 24 inches above top of buried pipe and run continuous along the length of pipe.
- B. Tracer tape used for non-metallic lines shall be metalized to allow pipe location without excavation. Locate tape approximately 6 inches from surface grade.
- C. Manufacturer: Calpico, Inc. Type II (detectable) or approved equal.

**2.4 VALVES**

- A. Isolation Valves:
  1. Size: ½ inch to 2 inch pipe size.
  2. Ball type, carbon steel, regular port, WOG rated.
  3. Chrome plated ball and stem.
  4. Blow-out proof, grounded stem.
  5. PTFE resilient seats and seals.
  6. Zinc plated handle with rubber handle cover.
  7. Manufacturer: Crane Tork-Seal No. 940, threaded, 2000CWP/150SWP, or approved equal.
- B. Check Valves:
  1. Size: ½ inch to 3 inch pipe size
  2. Screwed cap, Y pattern, swing type, bronze, threaded, WOG rated.
  3. Vertical or horizontal installation
  4. Manufacturer: Crane No. 37, threaded, or approved equal.
- C. Fusible Valves:
  1. UL listed.
  2. Bronze body.

3. Automatic shutting at 165 degrees F.
  4. Self-adjusting stuffing box.
  5. Backseat feature.
  6. Threaded, flared or combination fittings.
  7. Manufacturer: Firomatic, or approved equal.
- D. Oil Safety Valves:
1. UL listed.
  2. Provide positive shut-off of fuel supply in the event of downstream pipe failure.
  3. Manufacturer: Webster Model OSVA, or approved equal.
- E. Anti-Siphon Valves:
1. UL listed.
  2. Automatically shuts off the oil flow in the event of a broken or left open oil suction line.
  3. Constructed of heavy bronze material.
  4. Size:  $\frac{3}{4}$  inch.
  5. Suitable for all grades of fuel, including No. 6 oil.
  6. Manufacturer: Preferred Utilities, Model A, or pre-approved equal.

## 2.5 THREAD SEALANT

1. All threaded connections are to be sealed with a UPC listed, lead-free, paste thread sealant compatible with the product and piping materials specified.
2. Threaded connections which must be disassembled for periodic maintenance shall be sealed with a UPC listed, lead-free, non-seizing type, paste thread sealant compatible with the product and piping materials specified.
3. Manufacturer: Real-Tuff™, Grrip™, or approved equal.

## 2.6 FUEL FILTERS

- A. UL listed.
- B. Filter capacity: 25 microns.
- C. Manufacturers: General Filter, Firomatic, or approved equal.

## 2.7 GAUGES

- A. 2-1/2 inch diameter gauge, suitable for oil service.
- B. Accuracy at two percent of range.
- C. Select pressure range for normal; indicate in the middle third of range.
- D. Manufacturer: Trerice or equal.

## 2.8 FILTERS

- A. Suitable for pressure type burners, UL listed.
- B. 12 psig working pressure.
- C. 60 GPH firing rate.
- D. Filter capacity: 25 microns.
- E. Manufacturers: General Filter, Firomatic, or approved equal.

## 2.9 ELECTRONIC LEAK DETECTION SYSTEM

- A. Provide AST-1 mounted leak detection alarm panel with AST-1 interstitial space and two transition sump leak detection probes (3 total). System to include the following features:
  1. U.L. listed.
  2. Alarm panel with intrinsically safe relays housed in a NEMA-4X enclosure.
  3. Alarm panel to include status lights, alarm buzzer and push-to-test/alarm silence button.

4. Auxiliary alarm contact for connection to building automation system (BAS).
  5. Leak detector switches with Buna N float and weighted collar. Mfr: Gems, Model LS-750 Series.
- B. Manufacturer: Anchorage Tank and Welding, Inc., Model: Anchorage Tank Monitor 1 or pre-approved equal.

## 2.10 PACKAGED DAY TANK

- A. Provide packaged day tank system of the size, capacity, and with tappings as scheduled. Construct day tank to UL standards and provide UL label.
- B. Packaged day tank to include the following standard equipment:
1. Seam welded steel tank with removable top plate, steel channel feet with mounting holes. Epoxy coated tank interior. Enamel coated tank exterior.
  2. Welded flange pipe and vent tappings.
  3. Overflow basin with screened top, float switch sensor and quick drain.
  4. 3 GPM hydraulic gear over-fill return pump (1/2 HP, 120 VAC).
  5. 1 GPM hand pump.
  6. 2 suction tubes.
  7. 2 inch manual locking fuel fill cap.
  8. Vent cap.
  9. Pump intake solenoid valve.
- C. Remote pumping package to include:
1. NEMA-3R wall mounted cabinet.
  2. 2 GPM hydraulic gear fuel oil supply pump (1/3 HP, 120 VAC).
  3. Pump motor starter with overload relay.
  4. Pump motor disconnect with door handle interlock.
  5. Pump inlet and outlet ball type shut-off valves.
  6. Priming tee and check valve assembly.
  7. Pressure relief valve.
  8. Fuel strainer.
- D. Packaged day tank to include the following control devices and alarms:
1. Power transformer.
  2. Power available pilot light.
  3. Pump "Run-Off-Automatic" mode selector switch.
  4. Pump running light.
  5. Remote high and low fuel level alarm dry signal contacts with auxiliary relay for connection to BAS.
  6. Local/remote low and high fuel level alarms.
  7. High fuel level automatic pump stop.
  8. Electric level gauge.
- E. Manufacturer: Simplex or pre-approved equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Fuel Transfer Containment Piping:
1. Install complete fuel transfer and leak detection system in accordance with the manufacturer's written installation and testing instructions.
  2. Grade underground containment piping at a minimum slope of 1/8 inch per foot to drain to leak detection sumps.
  3. Terminate containment piping system both at the above ground storage tank (AST-1) and at the mechanical room floor penetration with termination assemblies provided by the containment piping system manufacturer.
  4. Provide test fittings and test donuts at each leak detection sump termination point.

- B. Leak detection sumps:
  - 1. Locate a leak detection sump buried and adjacent to base of above ground storage tank (AST-1) and along the buried fuel pipe route to the mechanical room as shown.
  - 2. Grade fuel transfer containment piping to drain to leak detection sumps as shown.
  - 3. Install leak detector switches in each sump using internal support brackets such that switches are in contact with base of the sump. Route detector switch cables in conduit to leak detection monitoring panel located at AST-1.
- C. Above ground and interior fuel oil piping:
  - 1. Provide socket welded steel fuel piping routed as shown.
  - 2. Support piping (including trench mounted piping) with Unistut or equal, pre-engineered mechanic support system. Provide rubber inserts provided by the manufacturer at each pipe clamp.
  - 3. Label piping "FOS" and "FOR" and indicate flow direction using pre-manufactured self-adhesive pipe markers. Mfr: MSI, Model: MS-900 or equal.
- D. Day tank:
  - 1. Install and test packaged day tank in accordance with the manufacturer's installation, maintenance and operating instructions.
  - 2. Position tank for full accessibility.
  - 3. Anchor day tank base to existing concrete floor using appropriate concrete anchor bolts.
  - 4. Connect alarm monitoring contact(s) to building automation system (BAS).
- E. Equipment Connections:
  - 1. Provide the final operating connection to boilers in accordance with the specific equipment manufacturer's installation instructions.
  - 2. Provide leak tight, sheetmetal drip pans with 4 inch raised and rolled rims under each fuel oil burner, filter assembly, day tank and at any additional location susceptible to fuel oil leakage.

### 3.2 FIELD QUALITY CONTROL

- A. Air Tightness Testing:
  - 1. To prevent storage tank over-pressurization during associated fuel pipe pressure testing:
    - a. Disconnect product lines to be pressure tested at their storage tank connections and plug exposed tank openings with threaded plugs prior to connection of the pressure source.
    - b. Upon completion of the pressure test, de-pressurize product lines to ambient pressure, disconnect the pressure source and reassemble product pipes to their appropriate tank connections.
  - 2. Fuel Pipe Testing: Upon completion of the transfer piping installation and prior to backfilling (for underground piping), subject fuel piping to a 20 PSIG air tightness test, soaping joints and inspecting for bubbles. If lines have held product, or after backfilling, test lines hydrostatically to 110 percent of operating pressure, but not less than 20 PSIG.
  - 3. Secondary Containment System Testing: Upon completion of the transfer piping installation and prior to backfilling, provide an air tightness test of the transfer piping secondary containment system in accordance with the manufacturer's written test instructions.
- B. Documentation:
  - 1. Fully document field testing to include the following:
    - a. Test Date and time.
    - b. Company and Person(s) conducting the test.
    - c. Test pressure and duration.
    - d. Department's Representative witnessing the test.
    - e. Legible signatures of all parties involved in the test certify that the test was satisfactorily completed as specified and in accordance with the manufacturer's written test procedures as applicable.

- f. Submit test documentation in accordance with submittal requirements.

### **3.3 ADJUSTING**

- A. Adjust systems in accordance with the manufacturer's written operation instructions.
- B. Adjust oil return line safety valve setpoint from the nominal setpoint indicated on the drawings to achieve an operating pressure as recommended by the burner manufacturer.

### **3.4 CLEANING, PAINTING AND LABELING**

- A. Verify day tank interior is clean and free of debris prior to initial fill tank.
- B. Thoroughly clean inside transfer pump enclosures, secondary containment voids and any other accessible, covered spaces prior to initial fuel fill and again prior to substantial completion.
- C. Thoroughly clean exterior piping and equipment surfaces prior to substantial completion.
- D. Paint new interior and exposed exterior fuel oil piping with one coat of a suitable rust-inhibiting primer and one final coat of heat-resistant black enamel paint to provide a uniform appearance. Paint piping prior to installing permanent piping clamps so that all piping surfaces are painted.
- E. Label fuel oil piping with self-adhesive pre-manufactured labels. Labels shall read "FUEL OIL SUPPLY" and "FUEL OIL RETURN" as appropriate in black letters on a yellow background with flow direction arrows. Manufacturer: Marking Services Incorporated (MSI) or equal.

### **3.5 DEMONSTRATION AND STARTUP**

- A. Startup fuel transfer system as part of boiler startup in accordance with the manufacturer's written start-up procedures. Test normal modes of operation, as well as, emergency overflow return pump operation.
- B. Demonstrate proper operation of the systems to the satisfaction of the Contracting Authority.
- C. Provide written documentation that demonstration and start-up of the systems and equipment has been satisfactorily completed.

**END OF SECTION 23 11 13**

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**SECTION 23 13 23**  
**ABOVEGROUND STORAGE TANKS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Aboveground fuel oil storage tanks and appurtenances.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 03 30 00 - Cast-in-Place Concrete
  - 3. 13 48 00 - Vibration and Seismic Control
  - 4. 20 00 00 - Mechanical General Requirements
  - 5. 20 05 29 - Hangers and Supports
  - 6. 20 05 53 - Mechanical Identification
  - 7. 23 05 93 - Testing, Adjusting and Balancing
  - 8. 23 11 13 - Fuel Oil Piping and Specialties
  - 9. 25 09 00 - Sequences of Operation
  - 10. 25 50 00 - Building Automation and Control
  - 11. Divisions 26, 27 and 28 - Electrical

**1.2 DESCRIPTION**

- A. This section describes specific requirements, products, and methods of execution relating to the aboveground fuel oil storage tank for this project.

**1.3 SCOPE**

- A. Provide new aboveground fuel oil storage tank (AST-1) systems in accordance with the drawings, the referenced publications, and the manufacturer's written installation instructions, checklists, and warranty requirements for each system component. AST-1 systems include the products, equipment, and systems identified in this section.

**1.4 CODES AND STANDARDS**

- A. Provide all work relating to Aboveground Storage Tanks and appurtenances in accordance with the minimum provisions of the following codes and standards:
- B. International Fire Code:
  - 1. Chapter 34: Flammable and Combustible Liquids.
- C. Underwriters Laboratories (UL) Standards:
  - 1. UL 142: Steel Aboveground Tanks for Flammable and Combustible Liquids.
- D. National Fire Protection Association (NFPA) Standards:
  - 1. Standard 30: Flammable and Combustible Liquids Code.

**1.5 QUALITY CONTROL**

- A. Installation of new tanks shall be in accordance with the tank manufacturer's written installation instructions.
- B. All work and materials shall be in accordance with requirements of the applicable State and local Codes, regulations and ordinances, International Building Code, Uniform Plumbing Code, International Mechanical Code, National Electrical Code, and the International Fire Code (including locally adopted amendments), the latest standards of the NFPA National Fire Codes, and the rules and regulations of all other Authorities Having Jurisdiction. Nothing in

drawings and specifications shall be construed to permit work not in conformance with applicable codes, rules, and regulations.

- C. Where drawings or specifications call for a material or construction of a better quality or larger sizes than required by the above-mentioned Codes, rules and regulations, the provision of the specifications shall take precedence.
- D. Provide without charge any additional material and labor required for compliance with these Codes, rules and regulations, even though the work may not be mentioned in the specifications or shown on the drawings. It shall be the responsibility of the successful bidder to bid in accordance with the minimum requirements of the applicable Codes, rules, and regulations.
- E. All electrical Motors, starters, controls, devices and wiring shall comply with standards of NEC and shall be UL listed and so identified.

## 1.6 DRAWINGS

- A. Drawings are diagrammatic and show the general design, arrangement and extent of the systems. Do not scale or attempt to use drawings for roughing-in measurements or as shop drawings.
- B. Investigate capacity and space requirements of the proposed equipment before submitting shop drawings.
- C. Obtain field measurements and prepare detailed shop drawings for submittal, demonstrating coordination with equipment and systems being provided by trades.
- D. Where conditions necessitate rearrangement or equipment and/or systems, prepare and submit to the Department's Representative for review, drawings of the proposed rearrangement. Due to the scale of the drawings, it is not possible to show all offsets, fittings, and accessories which may be required.

## 1.7 SUBMITTALS

- A. Product Data:
  - 1. Provide submittal data in accordance with the general requirements of Section 20 00 00 - Mechanical General Requirements. Include the additional submittal information specific to the equipment specified by this section as followings:
    - a. Provide manufacturer's literature that fully demonstrates compliance with the manufacturing methods, appurtenances and salient features specified.
    - b. Mark manufacturer's literature to indicate exactly those items that are to be provided and cross out unrelated or non-applicable items. In addition, submit manufacturer's detailed installation instructions on all equipment and materials submitted.
- B. Substitutions:
  - 1. Additional costs associated with design modifications as a result of proposed product substitutions shall be borne by the Contractor.
- C. Shop Drawings:
  - 1. Submit shop drawings for the above ground storage tank which show principal dimensions, materials, fitting locations with sizes and thread type and anchoring method. Coordinate shop drawings with work of other trades.
- D. Installation, Operation and Maintenance (IO&M) Manual:
  - 1. Provide a complete copy of the manufacturer's written installation, operation and maintenance manual to include the following information:
    - a. Manufacturer's descriptive literature.
    - b. Installation instructions.
    - c. Operating instructions.
    - d. Troubleshooting guide.
    - e. Preventative maintenance requirements.

- f. Complete parts list.
- g. Recommended spare parts list.
- 2. Neatly annotate the O&M manual to clearly indicate information applicable to the equipment installed.
- E. Closeout Submittals:
  - 1. Project record drawings:
    - a. Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation of the equipment.
  - 2. Provide a certificate from the Manufacturer's Representative indicating that the equipment and systems provided have been installed and are operational in accordance with the manufacturer's written installation, operation and maintenance manual and the adjustment requirements required by the Part 3.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Underwriters Laboratories under UL142 Standard shall list the entire tank system, including the skid and secondary containment, for Safety as a complete and indivisible unit. The skid mounted tank assembly shall bear the UL listing marking.

### **2.2 DOUBLE WALLED ABOVEGROUND TANKS FOR THE STORAGE OF PETROLEUM PRODUCTS**

- A. Tank:
  - 1. Above ground fuel oil storage tanks shall be of double wall (Type I), welded steel construction and guaranteed compatible with the contents indicated in the drawings.
  - 2. Construction of the outer tank shall be separate but in intimate contact with the inner tank and shall encompass 300 degrees of the circumference. The inner and outer tank shells and the tank heads shall be as required by the UL 142 listing. Head bracing shall be as required by the standard.
  - 3. Flat unflanged heads shall not be permitted on either inner or outer tanks.
- B. Skid:
  - 1. The skid rails shall be constructed of structural steel beam and shall be listed as an integral part of the tank.
  - 2. Skid supports shall be constructed of plate steel, equal in thickness to the inner tank with a 90 degree bent edge, 1 inch wide, at each side of the structural support. Supports shall be placed directly under the inner tank heads and thereafter, evenly spaced along the tank. Spacing between supports shall not exceed 69 inches. The skid supports shall be attached to a 12-inch wide saddle pad attached to the outer tank shell that is of sufficient length to encompass the bottom 120 degrees of the tank.
  - 3. A capped length of schedule 80 pipe shall be attached to each end of the skid to function as a tow bar when the tank is empty. The skid rail beam member shall encircle the full 360 degrees of the tow bar.
- C. Weld joints:
  - 1. All joints on the inner and outer shell and tank heads shall be as required by the UL 142 listing. In addition, all non-structural external seams shall be seal welded before Painting.
  - 2. All weld spatter shall be removed and all sharp edges shall be rounded and smoothed by grinding.
- D. Tank attachments and penetrations:
  - 1. Piping penetrations shall be made through the top of the tank only with sizes and locations as shown on the drawings.
  - 2. Secondary containment shall allow for the full recovery of a release from the inner tank into the annular space between the inner and outer tanks.

3. An additional fitting shall be incorporated into the tank (typically located on the top of the opposite end of the tank from the monitoring port) to allow flushing of any product which may accumulate as a result of release or an accidental fill of the annular space.
  4. The tank shall be equipped with lifting lugs adequate for the safe handling of the tank during installation. Each lifting lug must be designed to support the total weight of the empty dual wall tank system. A minimum of two lifting lugs shall be provided on tanks having a rated capacity of more than 1,100 gallons of product.
  5. Provided welded unistut attachment brackets for the attachment of the remote fuel oil transfer pump cabinet and vertical fuel oil pipe supports to the side of tank.
- E. Inspection and testing:
1. Prior to Painting, each tank shall be tested per UL 142 by the tank manufacturer to determine that the tank does not leak. Rewelding shall repair all leaks and the tank retested until no leaks are present.
- F. Finishes:
1. All exterior surfaces shall be cleaned and prepared by sandblasting in accordance with Steel Structures Painting SSPC-3 requirements and thereafter painted in accordance with the manufacturer's recommendations, with Department's Representative approval.
  2. It shall not be necessary to blast and paint the interstice.
- G. Warning signs and placards:
1. The tank shall be provided with appropriate, permanently attached, warning labels and/or placards in accordance with International Fire Code requirements, based on nominal tank capacity and the contents being stored.
- H. Miscellaneous:
1. Thread protectors or plugs shall be installed in each tank opening during storage and shipment to the site. Protectors and plugs shall include vent holes to allow pressure venting of the tanks while in storage.
  2. Installation and field-testing shall be per Steel Tank Institute F921 Standard.

### 2.3 TANK APPURTENANCES

- A. General: Tank appurtenances shall be as shown on drawings and specified below. Appurtenances shall be Underwriters Laboratories (UL) listed for storage of petroleum products. Appurtenances shall, where practical, be shop installed, tested and painted/coated with the same coating provided for the tank before shipment to the site.
- B. Containment Manhole Fill Box:
1. Welded steel construction.
  2. Lockable, hinged, weather-tight gasketed lid.
  3. Three 4 inch tank bosses.
  4. Drain valve to tank.
  5. Manufacturer: Anchorage Tank and Welding Inc., Greer, Ace Tank.
- C. Suction Foot Valve:
1. 3/4 inch, double poppet.
  2. Bronze body and poppet.
  3. 8 mesh screen.
  4. 3/4 inch FPT connection.
  5. Manufacturer: OPW 92-0033, or approved equal.
- D. Fill Limiter Assembly:
1. Assembly shall be compatible with 4-inch tank opening.
  2. 2-inch diameter dry-break coupler with dust cap.
  3. Aluminum fill tube with adjustable collar, 4 inch FPT connection.
  4. Float valve with positive shut-off.
  5. Aluminum drop tube.

6. Size fill pipe and drop tube for 90 percent product level shutoff based on tank diameter as per manufacturer instructions. Drop tube shall extend to within 6 inches of tank bottom.
  7. Manufacturer: Clay and Bailey F-30, Morrison 9095A, or approved equal.
- E. Emergency Vent:
1. Cast iron body.
  2. Lid design that minimizes weather effects.
  3. Brass fire/spark arresting screen.
  4. Manufacturer: Clay and Bailey No. 368, or approved equal.
- F. Normal Vent:
1. Aluminum body and cap for upward venting.
  2. Removable brass 40 mesh screen.
  3. 2-inch size with threaded NPT or Setscrew connection.
  4. Manufacturer: OPW 23-0033, Clay and Bailey No. 395, Emco Wheaton MR 354, or approved equal.
- G. Mechanical Level Gauge:
1. Continuous level indicating float gauge.
  2. ¼ inch accuracy.
  3. 2 inch MPT connection.
  4. Manufacturer: Morrison, Model 818 "clock gauge", or approved equal.

## 2.4 INVENTORY CONTROL AND LEAK DETECTION

- A. Not required. Leak detection for aboveground tanks can be by visual inspection. Provide an additional 2" vent opening at each end of tank; one with riser and vent cap, the second with threaded cap for visual inspection.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install new AST system in accordance with the drawings, the referenced publications, and the manufacturer's written instructions, checklists, and warranty requirements for each system component.
- B. Bolt AST skid to concrete housekeeping pad with concrete type stainless steel anchor bolts. Size anchor bolts in accordance with Section 13 48 00 – Vibration and Seismic Control.

### 3.2 TANK TESTING

- A. Tanks are to be shop tested before being placed in service in accordance with UL 142. The listing mark of the Underwriters Laboratories, Inc. on the tank shall be evidence of compliance with this test.
- B. Where the vertical length of fill and vent pipes is such that when filled with liquid, the static head imposed on the bottom of the tank exceeds 10 psig (23 ft WC), the tank and related piping shall be tested hydrostatically to the pressure equal to the static head imposed.
- C. To prevent storage tank over-pressurization during associated product pipe pressure testing:
1. Disconnect all product lines to be pressure tested at their storage tank connections and plug exposed tank openings with threaded plugs prior to connection of the pressure source.
  2. Upon completion of the pressure test, de-pressurize product lines to ambient pressure, disconnect the pressure source and reassemble product pipes to their appropriate tank connections.

**3.3 ADJUSTING**

- A. Adjust fuel limiter assembly to provide fuel fill shut-off at ninety (90) percent tank capacity in accordance with the fuel limiter assembly installation and operation instructions. Document fuel limiter valve elevation (in inches) with respect to the inside base of the tank.
- B. Adjust fuel tank level gauge assembly to provide accurate fuel level measurement in accordance with the fuel gauge assembly installation and operation instructions. Verify that fuel level gauge accuracy is within the manufacturer's listed tolerance during initial fill. Document that fuel level gauge accuracy has been verified.

**END OF SECTION 23 13 23**

**SECTION 23 21 13**  
**HYDRONIC PIPING AND SPECIALTIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Pipe, fittings and accessories.
  - 2. Valves.
  - 3. Expansion tanks.
  - 4. Air vents.
  - 5. Air separators.
  - 6. Strainers.
  - 7. Flow indicators, controls, meters.
  - 8. Relief valves.
  - 9. Glycol specialties.
  - 10. Heat Exchangers.
  - 11. Flushing agent and cleaning agents.
  - 12. Access doors.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 20 07 00 - Mechanical Insulation
  - 7. 23 05 93 - Testing, Adjusting and Balancing
  - 8. 23 21 14 - HVAC Pumps
  - 9. 23 36 00 - Air Terminal Units
  - 10. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 11. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 12. 23 64 00 - Packaged Water Chillers
  - 13. 23 70 00 - Central Air Handling Units
  - 14. 23 81 16 - Room Air-Conditioning Units
  - 15. 23 82 00 - Terminal Heating and Cooling Units
  - 16. 23 83 00 - Radiant Floor Heating Equipment
  - 17. 23 83 01 - Snow Melting Equipment
  - 18. 25 09 00 - Sequences of Operation
  - 19. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. International Mechanical Code (IMC).
- C. ANSI/ASHRAE/IESNA Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. This section describes specific requirements, products and methods of execution for the system of liquid heat transfer throughout the project. The system of heat generation is specified elsewhere.

2. Design expansion compensation system to adequately protect piping and structure from thermal expansion and contraction forces.
- B. Performance Requirements:
  1. Provide performance and output shown or scheduled on drawings.
  2. Provide loops, pipe offsets, and swing joints, or expansion joints where required or indicated.
  3. Pipes shall be capable of thermal expansion movement without disengagement of supports.
  4. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
  5. Expansion Calculations:
    - a. Installation Temperature: 40 degrees F.
    - b. Hot Water Heating: 210 degrees F.
    - c. Chilled Water Cooling: 55 degrees F.
    - d. Well Water Cooling: 42 degrees F.
    - e. Domestic Hot Water: 140 degrees F
    - f. Safety Factor: 30 percent.

#### 1.4 SUBMITTALS

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.
  2. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  3. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
  4. Submit selection calculations for expansion joints and compensators.
- C. Shop Drawings:
  1. Submit shop drawings for performance-specified products and systems.
  2. Submit shop drawings for piping systems to demonstrate proper layout and coordination.
  3. Provide shop drawings to show system layout with location and detail of flexible pipe connectors and expansion joints.
  4. Drawings of boiler room, fan rooms, and other areas with high-density piping, shall be shown at 1/4-inch scale or larger.
  5. Indicate elevation of piping above finish floor.
  6. Indicate dimensions and weights of equipment, and placement of openings and holes.
  7. Include reference to ductwork and other equipment where space coordination is necessary to avoid conflicts.
  8. Indicate mechanical and electrical service locations and requirements.
- D. Quality Control/Control Submittals:
  1. Design Data: Submit calculations for performance specified products and systems.
  2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.

- b. Included with the manual one (1) copy of the completed start-up and operation checklist. The checklist shall include:
  - 1). Printed names and signatures of the installers.
  - 2). Documentation from Manufacturer's representative and the Department's Representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
- 3. Provide test reports:
  - a. Provide certificate that cleaning of hydronic systems has been accomplished.
  - b. Provide certificate listing satisfactory results for the hydrostatic tests.
  - c. Provide certificate listing satisfactory results for the operational tests.
- E. Closeout Submittals:
  - 1. Project Record Documents: Record actual locations of valves, strainers, air vents, flexible pipe connectors, expansion joints, other components, and locations of access doors required for access.
  - 2. Operation and Maintenance (IO&M) Manuals:
    - a. Refer to Section 20 00 00 – Mechanical General Requirements, for O&M Manual formatting requirements and number of copies required.
    - b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  - 1. Manufacturer Qualifications:
    - a. Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
  - 2. Acceptable Installers:
    - a. Minimum three years experience in the installation and start-up of hydronic systems and equipment.
- B. Pre-Installation Meetings:
  - 1. Fully coordinate installation of hydronic systems and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any hydronic components.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
  - 3. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- B. Storage and Protection:
  - 1. Store products outside the general construction zone in covered storage area protected from the elements, until installed. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements.

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND FITTINGS**

- A. Water Systems:
  - 1. Type L copper pipe three inches and Smaller: Wrought copper fittings.
  - 2. Steel Pipe four inches and Larger: Welded pipe and fittings.
    - a. Grade B, seamless, ASTM A53 or A106.
    - b. Schedule 40 black with ANSI B16 butt weld fittings of type and wall thickness to suit pipe.
  - 3. Victaulic or Gustin-Bacon mechanical joint type pipe systems are not permitted.
  - 4. Galvanized piping is not permitted.
- B. Glycol Systems (Copper or Steel Option):
  - 1. Copper Pipe: Type L copper, wrought copper fittings.
  - 2. Steel Pipe: Welded pipe and fittings. No threaded pipe allowed.
  - 3. Victaulic or Gustin-Bacon mechanical joint-type pipe systems are not permitted.
  - 4. Galvanized piping is not permitted.
- C. Well Water Cooling System
  - 1. Plastic pipe and fittings:
    - a. Schedule 80 PVC conforming to ASTM D-1785, Type 1, Grade 1. Gray color.
    - b. Socket and flanged fittings. Provide 316 stainless steel nuts, bolts and washers at all flanged connections.
    - c. Pressure Rating: 150 PSIG (at 73 Deg F).
    - d. Temperature Rating: 140 Deg F (Maximum)
    - e. Mfr: Harrington Industrial Plastics or approved equal.
  - 2. Butterfly isolation valves:
    - a. Lug type, PVC body and disc
    - b. Pressure Rating: 150 PSIG (at 73 Deg F).
    - c. Temperature Rating: 140 Deg F (Maximum)
    - d. 316 stainless steel stem.
    - e. Field replaceable seat.
    - f. High impact polypropylene level handle.
    - g. Mfr: Spears or approved equal.
  - 3. Pipe adaptors: Socket weld threaded or flanged.
  - 4. Solvent cement: ASTM D-2564.
- D. Equipment drains and overflows:
  - 1. Type L copper pipe, wrought copper fittings.

### **2.2 VALVES**

- A. Manufacturers: Crane, Nibco, Hammond, Jenkins, Grinnell, Milwaukee, Stockham or pre-approved equal.
- B. General:
  - 1. Select valves of the best quality and type suited for the specific service and piping system used. Minimum working pressure rating 125 psig saturated steam or 200 psig W.O.G. Packing material or seals shall not contain asbestos.
- C. Ball Valves:
  - 1. Two (2) inches and smaller: Two piece type, full port, bronze body and ball, TFE seats, blowout proof stem, 150 psig pressure/temperature rating (steam).
  - 2. Two and one half (2-1/2) inches through four (4) inch: Two piece type, full port, bronze body and ball, TFE seats, 150 psig pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.

3. Six (6) inch and larger: Two piece type, full port, carbon steel body and ball, TFE seats, 150 psig pressure/temperature rating (steam). May be substituted for gate valves except where otherwise indicated.
- D. Gate Valves:
1. Two (2) inches and smaller: Bronze body and trim, rising stem, solid wedge. Use only where shown on drawings.
  2. Two and one half (2-1/2) inches through four (4) inch: Iron-body, bronze trim, flanged threaded or sweat fitting. Non-rising stem: Inside screw. Rising stem: OS&Y. Bronze valves optional for 2-1/2 inch and three-inch.
  3. Six (6) inch and larger: Iron body bronze trim, flanged. Rising stem: OS&Y, or non-rising stem with solid wedge.
- E. Globe Valves:
1. Two (2) inches and smaller: Bronze body, renewable disc suitable for service.
  2. Two and one half (2-1/2) inches and larger: Iron body, bronze trim, flanged, bronze disc. Bronze valves optional for 2-1/2 inch and three-inch.
- F. Swing Check Valves:
1. Two (2) inches and smaller: Bronze body, horizontal swing, Y-pattern, Buna-N-disc for water, oil and gas. TFE disc for steam.
  2. Two and one half (2-1/2) inches and larger: Iron body, horizontal swing, bolted bonnet, renewable bronze seat and disc, flanged.
    - a. Bronze valves optional for 2-1/2 inch and three (3) inch.
- G. Drain Valves: Full port ball valve with threaded hose adapter with bronze end cap. Do not use sillcocks or butterfly valves as drain valves.
- H. Valves Specified Elsewhere: Provide special valves such as motor-operated valves, relief valves, temperature regulating valves, etc., as specified under the individual system or as indicated on the drawings.

### **2.3 UNIONS (STANDARD)**

- A. Steel Piping (Threaded):
1. Class 150 malleable iron, ground joint, copper or copper alloy seat. Grinnell No. 463. (150 psig steam, 300 WOG).
  2. Where indicated: Class 250 malleable iron ground joint, copper or copper alloy seat. Grinnell No. 554.
- B. Copper Piping (Sweat and Threaded): Cast brass, ground joint, copper to copper, or copper to threaded joint. Grinnell No. 9730 - 9739.

### **2.4 DIELECTRIC ISOLATORS (ELECTRICALLY INSULATING)**

- A. Provide dielectric unions or bronze close nipples for two inch pipe and smaller.
- B. Provide dielectric flanges for 2-1/2 inch pipe and larger.
- C. Insulating gaskets, all types, shall be suitable for fluid type, temperature and pressure.
- D. Galvanized pipe to copper: Brass threaded end and sweat copper end.
- E. Black steel to copper: Zinc plated steel threaded end and sweat copper end.
- F. Manufacturers: Capitol, Epco, Control Plastics, Watts, or approved equal.

### **2.5 BRONZE THREADED NIPPLES**

- A. Bronze threaded nipples and bronze body valves may be used in lieu of dielectric isolators in heating system piping for the separation of black steel and copper piping.

## 2.6 PRESSURE GAUGES

- A. Provide where shown on drawings, specified in Part 3, or as required.
- B. Bourdon tube type with 4-1/2-inch dial (minimum) accuracy plus or minus one-percent span, re-calibratable. Normal operating pressure near midpoint of range. Industrial quality.
- C. Gauge cock on gauges and pulsation damper (snubber). Steam gauges shall have siphon to isolate gauge from steam, except where remotely mounted and connected by looped tubing.
- D. Differential pressure gauges shall be piston or diaphragm type with range suitable for application and static pressure capability suitable for system pressure. Orange Research.

## 2.7 THERMOMETERS

- A. Provide where shown on drawings, specified in Part 3, or as required.
- B. Liquid in glass type: Industrial quality red-reading with nine-inch scale length (minimum). Straight angle or adjustable as necessary for visibility.
- C. Dial Type: Industrial quality three-inch dial with 270 degrees (minimum) scale length. Straight, angle or remote as necessary for visibility.
- D. Normal operating temperature at scale midpoint and sufficient range to comfortably cover operating conditions.
- E. Provide separable wells of suitable material for piping and mounting hardware for ducts. Set probe in heat transfer paste recommended by thermometer manufacturer.
- F. Manufacturers: Trerice, Marsh, Weksler, or approved equal.

## 2.8 PRESSURE AND TEMPERATURE TEST PLUGS

- A. Provide where shown on drawings, specified in Part 3 or as required.
- B. Standard type for 1/8-inch diameter pressure or temperature probes. Self seal when probe removed and complete with threaded cap. Minimum continuous rating 125 psig and 220 degrees F. coincident. Sealing element suitable for fluid in pipe.
- C. Provide one thermometer and one pressure gauge for each range required by system parameters.
- D. Manufacturers: Sisco, Peterson Equipment, or approved equal.

## 2.9 FLEXIBLE PIPE CONNECTORS

- A. General:
  - 1. System Application: Hot water heating or fifty percent (50%) propylene glycol solution heating.
  - 2. System Maximum Operating Temperature: 210 Degrees F.
  - 3. Pressure: Internal.
  - 4. Installation: Straight or Offset as shown.
  - 5. Movement: Constant or Intermittent.
  - 6. Maximum offset: Not to exceed 25 percent of the centerline bend radius.
  - 7. Determine appropriate minimum "live hose length" (flexible portion of assembly) based on the centerline bend radius for each application in accordance with manufacturer's sizing tables.
- B. Copper Pipe Flexible Connectors - Small Diameter (Sweat):
  - 1. Size: 3/4 inch through 2-1/2 inch nominal pipe size (NPS).
  - 2. Pipe Ends: Copper tube sweat.
  - 3. Corrugated Hose: Bronze.
  - 4. Outer Braid: Single braided bronze.
  - 5. Minimum Working Pressure Rating: 120 PSIG at 250 Degrees F.
  - 6. Maximum Temperature Rating: 250 Degrees F.

7. Manufacturers:
  - a. Metraflex
  - b. Keflex
  - c. Pre-approved equal.
- C. Copper Pipe Flexible Connectors - Small Diameter (Removable):
  1. Size: ¾ inch through 2-1/2 inch nominal pipe size (NPS).
  2. Pipe Ends: Female pipe coupling, Female union, Male Hex Nipple, Male Pipe with Hex Nut.
  3. Corrugated Hose: Bronze.
  4. Outer Braid: Single braided bronze.
  5. Minimum Working Pressure Rating: 120 PSIG at 250 Degrees F.
  6. Maximum Temperature Rating: 250 Degrees F.
  7. Manufacturers:
    - a. Metraflex
    - b. Keflex
    - c. Pre-approved equal.
- D. Steel Pipe Flexible Connectors - Large Diameter:
  1. Size: 3 inch through 10 inch nominal pipe size (NPS).
  2. Pipe Ends: 150 LB plate steel flat faced flange.
  3. Corrugated Hose: Type 304 stainless steel.
  4. Outer Braid: Single braided Type 304 stainless steel.
  5. Minimum Working Pressure Rating: 150 PSIG at 250 Degrees F.
  6. Maximum Temperature Rating: 250 Degrees F.
  7. Manufacturers:
    - a. Metraflex
    - b. Keflex
    - c. Pre-approved equal.

## 2.10 EXPANSION JOINTS

- A. General:
  1. Minimum Rating: 125 psig WSP and 450 degrees F.
  2. Size: Use pipe-sized units.
  3. Joint type: Match joint type specified for pipe joints.
- B. Packed Expansion Joints:
  1. Description: Packed metal expansion joints with abrasion-free internal and external guides, Schedule 80 slip tube with 0.002 inch thick hard chrome plated seal surface, and graphite flake injectable combination packing and lubricant. Designed to allow packing/lubricant to be injected under full line pressure.
  2. Rating: 150 psig (1035 kPa) WSP and 750 degrees F.
  3. Application: Copper or steel piping two inch (50 mm) and over.
  4. Joint: Flanged end.
  5. Accessories: Anchors, guides and supports as recommended by manufacturer for each specific installation.
  6. Manufacturers: Hyspan Series 6500 PERMA-PAK.

## 2.11 PIPE ALIGNMENT GUIDES:

1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum one inch (25 mm) thick insulation, minimum three inches (75 mm) travel.

## 2.12 EXPANSION TANKS

- A. Construction:
  1. Designed, tested and stamped in accordance with ASME standards.

2. Welded steel shell and base with heavy-duty butyl diaphragm.
  3. Forged steel system connections.
- B. Ratings:
1. Working pressure: 125 psig.
  2. Working Temperature: 240 degrees F.
  3. Pre-charge: 12 psig.
- C. Accessories:
1. Pressure gage.
  2. Air charging fitting.
  3. Tank drain isolation valve.
  4. System connection isolation valve.
- D. Model and size: As scheduled.
- E. Manufacturers: Amtrol (Basis of Design), Taco, Armstrong.

### 2.13 AIR VENTS

- A. Coin operated vent: Manual low profile vent for use in baseboard and other enclosures where automatic vent will not fit. 150 PSIG working pressure, 212 degrees F. operating temperature. Bell & Gossett No. 4V or approved equal.
- B. Float Type:
1. 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. Iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.
  3. Operating pressure 75 psig, hydrostatic pressure 200 psi maximum, intended for use in hot or cold lines. Provide ball type isolation valves for air vents that do not have integral shut off valves.
  4. Manufacturers: Honeywell EA791004, Hoffman No. 79.
- C. Disc Type:
1. Designed to be replaced without removal from line, with built-in check valve.
  2. Limited to baseboard, unit ventilators, cabinet unit heaters, convectors, and elsewhere where air vent must be installed in a cabinet or enclosure, unless other type detailed on drawings.
  3. Maximum working pressure 50 psig.
  4. Manufacturer: Hoffman No. 500, or equal.

### 2.14 AIR SEPARATORS

- A. Construction:
1. Designed, tested and stamped in accordance with ASME standards.
  2. Welded steel shell with flanged connections.
- B. Ratings:
1. Working pressure: 125 psig (minimum).
  2. Working Temperature: 125 degrees F. (minimum).
- C. Manufacturers: Spirotherm (Basis of Design), Taco, B&G or pre-approved equal.

### 2.15 STRAINERS

- A. Size two inch and under:
1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32-inch stainless steel perforated screen.

- B. Size 2-1/2 inches to four inches:
  - 1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64-inch stainless steel perforated screen.
- C. Size five inches and larger:
  - 1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8-inch stainless steel perforated screen.
- D. Manufacturers: Metraflex, Armstrong, Crane, Hayward, Watts Regulator, Hoffman, Sarco.

#### **2.16 WELL WATER STRAINER**

- A. Duplex strainer designed for continuous flow applications.
- B. 316 Stainless steel construction with 150 Lb flanged connections.
- C. 316 stainless steel diverter and baskets.
- D. Nitrile seals.
- E. Mounting hardware
- F. Maximum working Pressure: 275 PSIG @ 100c Deg F water.
- G. Maximum pressure drop of 1.5 PSIG at 580 GPM.
- H. Approximate operating weight: 673 Lbs.
- I. Equipment Ip: 1.5
- J. Manufacturers: Stayflow Strainers, Model: DSF0600 or pre-approved equal.

#### **2.17 AUTOMATIC FLOW LIMITING AND ISOLATION VALVES**

- A. Supply pipe side: Brass alloy body with stainless steel flow cartridge assembly, integral ball valve, 20 mesh strainer element, two pressure/temperature test valves and drain valve with hose bibb adapter and end cap. Body design allows removal of flow cartridge without disturbing piping connections. Threaded sweat adapter inlet. Union with sweat adapter outlet.
- B. Return pipe side: Forged brass body with integral ball valve, pressure/temperature test valve and manual air vent. Union with sweat adapter inlet. Threaded sweat adapter outlet.
- C. Calibration: Control flow within five percent of selected rating, over operating pressure range of at least 10 times minimum pressure required for control. Provide three operating pressure ranges with a minimum range requiring less than 3.5 PSID to actuate flow control cartridge.
- D. Flow Control Cartridge: Stainless steel one piece cartridge with segmented port design and full travel linear coil spring.
- E. Provide supply and return components packaged as a system and labeled in accordance with the equipment schedule tag to match terminal heating unit served.
- F. Manufacturer: Griswold Controls or approved equal.

#### **2.18 BALANCING VALVES**

- A. Provide calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device. Include schedule with submittal.
- B. Manufacturers: Bell & Gossett, Taco, or equal.

#### **2.19 RELIEF VALVES**

- A. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.
- B. Manufacturers: Watts Regulator, or equal.

## **2.20 PLATE HEAT EXCHANGERS (HEATING)**

- A. Provide plate type heat exchanger(s) with the heat transfer and hydraulic performance characteristics as scheduled.
- B. Heat exchangers to include the following:
  - 1. Frame: Carbon steel with baked epoxy paint, side-bolts and plate shroud.
  - 2. Channel plates: Type 304 stainless steel.
  - 3. Tightening bolts: Steel.
  - 4. Gasket material: Nitrile (glycol compatible).
  - 5. Nozzles: 2" NPT carbon steel.
- C. Manufacturers: Bell & Gossett, Trantor, Mueller, or approved equal.
- D. Field fabricated heat exchanger support frame.
  - 1. Provide a field fabricated, steel, heat exchanger support frame which elevates the heat exchanger base to 30" above the finished floor. Bolt the heat exchanger frame to the support frame. Anchor the support frame to the concrete housekeeping pad with concrete anchor bolts (Hilti Kwik-Bolt or equal).
  - 2. Prime and paint the support frame to match the heat exchanger frame. Submit dimensioned shop drawings of the support frame for approval by the Department's Representative prior to fabrication.

## **2.21 BRAZED PLATE HEAT EXCHANGERS (HEATING)**

- A. Provide plate type heat exchanger(s) with the heat transfer and hydraulic performance characteristics as scheduled.
- B. Heat exchangers to include the following:
  - 1. Cover plates: Stainless steel ASTM 316L.
  - 2. Channel Plates: Corrugated stainless steel ASTM 316L, vacuum brazed together.
  - 3. Brazing material: Copper.
  - 4. Connections: Stainless steel ASTM 316L.
  - 5. Design pressure: 435 PSIG.
  - 6. Design temperature: -310 degrees F (minimum) and 450 degrees F (maximum).
  - 7. Manufacturers: Bell & Gossett or approved equal.

## **2.22 PLATE HEAT EXCHANGERS (WELL WATER COOLING)**

- A. Provide plate type heat exchangers of material construction compatible with seawater with the heat transfer and hydraulic performance characteristics as scheduled.
- B. Heat exchangers to include the following:
  - 1. Frame and pressure plates: Carbon steel with baked epoxy coating. Stainless steel trim hardware and shroud plate.
  - 2. Channel plates: Type 304 stainless steel.
  - 3. Nozzles: Stainless steel flange connections.
  - 4. Gasket material: Nitrile.
- C. Manufacturers: Alfa Laval or approved equal.

## **2.23 FLUSHING AGENT**

- A. Synthetic organic dispersant:
  - 1. Manufacturer: Hydrochem 280 or pre-approved equal.

## **2.24 WATER TREATMENT**

- A. Hydronic loop treatment:
  - 1. Manufacturer: CH2O, Product 6439 or pre-approved equal.

## 2.25 GLYCOL SYSTEMS

- A. General: Provide equipment and products specifically designed and approved for continuous operation with the glycol solution specified.
- B. Glycol Solution:
  - 1. Inhibited propylene glycol solution premixed to 50 percent by volume for use with hydronic heating systems.
  - 2. Fluid analysis test kit.
  - 3. Manufacturer: Dow Chemical Company, model: Dowfrost. No substitutes.
- C. Automatic Glycol Make-up System:
  - 1. Provide packaged glycol make-up system as scheduled with single point electrical connection.
  - 2. Fill glycol make-up tank with approximately 35 gallons of clean solution when testing and final check out has been completed.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide finished products with protective covers during balance of construction.
- C. Provide accessible ball type isolation valves at major piping branches, and on main lines as shown, and at all terminal devices. For pipes 2-1/2 inches and larger butterfly valves may be used. Provide drains and manual vents at main line and branch line valves to facility draining and filling piping sections.
- D. Access Doors: Provide appropriate size and install such that hydronic system features are readily accessible and maintainable.
- E. Install balancing valves and automatic flow limiting valves to be accessible and adjustable.
- F. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish Painting in mechanical rooms and opened ceiling public spaces. Refer to Section 09 90 00 – Painting.
- K. Thermal Expansion:
  - 1. Install piping to allow for normal thermal expansion and contraction.
  - 2. Provide anchors where necessary and as shown.
  - 3. Provide expansion loops, expansion compensators, and alignment guides to suit conditions and as shown on drawings.
  - 4. Piping shall be guided and restrained as recommended by the manufacturer.
- L. Provide test plugs on both inlet and outlet sides of heat transfer elements to allow measurement of both fluid pressure drop and differential temperature.
- M. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

- N. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- O. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required or as indicated.
- P. Provide expansion loops as indicated on drawings.
- Q. Provide pipe anchors offsets, loops and expansion compensators as required to control the expansion of pipelines.

### 3.3 CONSTRUCTION

- A. Interface with other Work:
  - 1. Fully coordinate and sequence installation of hydronic products with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

### 3.4 REPAIR/RESTORATION

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.
- C. Touch-up finished surfaces with touch-up paint provided by the equipment manufacturer.

### 3.5 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Hydronic System Cleaning and Treatment Coordination Meeting:
  - 1. Conduct a meeting prior to flush cleaning and treatment of the hydronic heating and cooling systems to discuss cleaning agents, treatment chemicals and procedures to be used. Discuss system fill procedures with rust inhibited water and glycol solutions.
  - 2. Participants shall include the Contractor, subcontractor directly performing the work and The Department's Maintenance Staff personnel.
  - 3. Provide one (1)-week notice prior to the meeting.
  - 4. Cleaning, filling and treatment of the hydronic heating system is not permitted until this coordination meeting has been conducted and the Department's Representative's concerns have been addressed to the Department's Representative's satisfaction.
- C. System fill:
  - 1. After flush cleaning the hydronic heating and cooling systems, fill the primary and secondary heating systems and cooling systems with rust inhibited water and glycol solutions as applicable.
  - 2. Thoroughly vent the systems to include piping high points and equipment vents (pump casings, air separators, etc.).
- D. Site Tests:
  - 1. Hydrostatic Pressure Test:
    - a. Make sure hydronic heating system is filled with clean water and hydrostatically test system to 100 PSIG. System must hold test pressure for a two (2)-hour period with no pressure drop to pass test.
    - b. Inspect system during test and repair leaks.
    - c. Provide written report indicating that the pressure test has been satisfactorily completed.

2. Operational Test:
  - a. Inspect system for proper fluid circulation, sufficient clearance for expansion and contraction of piping and proper system pressure control.
  - b. Note and correct discrepancies and deficiencies.
  - c. Provide written report indicating that the operational test has been satisfactorily completed.

### **3.6 ADJUSTING**

- A. Adjust functional components for proper operation in accordance with manufacturer's recommendations, or as otherwise directed.
- B. Fully coordinate and work directly with the Balancing and Testing Agency to provide systems in proper operating order.
- C. Make corrections and adjustments in a timely manner as required by the Balancing and Testing Agency.

### **3.7 CLEANING**

- A. Thoroughly clean internal surfaces of the completed heating system as follows:
  1. Flush hydronic piping to remove black magnetic iron oxide and mill scale from the system.
  2. Flush system piping with synthetic organic dispersant to remove grease. Circulate solution through system at 150 degrees F. or greater for twelve to twenty-four hours.
  3. Repeat process until the system is clean to the satisfaction of the Department's Representative.
  4. Flush system with fresh water as necessary to remove residual cleaning agent.
  5. Exercise proper care during flushing and cleaning of systems to make sure no damage is done to equipment, valves, fittings, or Work of other trades. Restore damaged system components or Work of other trades to new or original condition at no additional cost to the Department.
- B. After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.

### **3.8 START-UP**

- A. Start-up and operate hydronic heating system in accordance with the manufacturer's written installation, operation and maintenance manuals as applicable.
- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

### **3.9 ADJUSTING**

- A. Test, adjust and balance hydronic heating system in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

**END OF SECTION 23 21 13**

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**SECTION 23 21 14**  
**HVAC PUMPS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. System lubricated circulators.
  - 2. In-line circulators.
  - 3. Vertical in-line pumps.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 23 - Motors
  - 9. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 10. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 11. 23 64 00 - Packaged Water Chillers
  - 12. 23 81 16 - Room Air-Conditioning Units
  - 13. 23 83 00 - Radiant Floor Heating Equipment
  - 14. 23 83 01 - Snow Melting Equipment
  - 15. 25 09 00 - Sequences of Operation
  - 16. 25 50 00 - Building Automation and Control
  - 17. 25 55 00 - Variable Speed Drives

**1.2 REFERENCES**

- A. NFPA 70 – National Electrical Code.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the pumping of heating fluid, which will be distributed to the locations shown. The method of generation of, and distribution of, this heat is specified elsewhere.
- B. Performance Requirements:
  - 1. Select pumps to 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.
  - 2. Provide performance and output shown or scheduled on drawings.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria.

2. Include the following:
  - a. Catalog data sheets for each pump scheduled. Indicate which model is being submitted.
  - b. Certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
  - c. Dimensional data.
  - d. Features and appurtenances being provided.
  - e. Electrical characteristics and connection requirements.
- C. Shop Drawings:
  1. Submit fully dimensioned shop drawings of boiler room showing major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown.
  2. Indicate mechanical and electrical service locations and requirements.
- D. Quality Control/Control Submittals:
  1. Design Data and Test Reports:
    - a. Provide design data and test reports for each pump.
  2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each installed pump. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - b. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      - 1). Printed names and signatures of the installers.
      - 2). Documentation from Manufacturer's representative and the Department's Representative that the pumps have been properly installed and is fully operational, thus validating the equipment warranty.
- E. Closeout Submittals:
  1. Project Record Documents: Record actual locations of pumps and associated valves, and areas required for maintenance access.
  2. Operation and Maintenance (O&M) Manuals:
    - a. Refer to Section 20 00 00 – Mechanical General Requirements, for O&M Manual formatting requirements and number of copies required.
    - b. Provide copies of approved submittal information for inclusion within the project O&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, assembly views, lubrication instructions, maintenance and repair data, parts listings, and spare parts list.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  1. Manufacturer Qualifications:
    - a. Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
  2. Acceptable Installers:
    - a. Minimum three years experience in the installation and start-up of pumps.
- B. Pre-Installation Meetings:
  1. Coordinate installation of pumps and associated piping and valves with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.
- C. Regulatory Requirements:
  1. 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Outside the general construction zone, store products in covered storage area protected from the elements, until installed. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. Provide one year manufacturer's warranty.
- B. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.
- C. Provide to the Department's Representative one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

## PART 2 - PRODUCTS

### 2.1 SYSTEM LUBRICATED CIRCULATORS

- A. Type: Horizontal shaft, single-stage, direct connected, with resiliently mounted motor for in-line mounting.
- B. Materials:
  - 1. Pump: Cast iron, with flanged pump connections.
  - 2. Impeller: Replaceable stainless steel cartridge.
  - 3. Mechanical Seal Assembly: None.
- C. Performance:
  - 1. As scheduled.
  - 2. Maximum working temperature: 230 degrees F.
  - 3. Maximum working pressure: 140 psig.
- D. Electrical Characteristics:
  - 1. As scheduled.
  - 2. 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.
- E. Manufacturers: Grundfos, Armstrong, Bell and Gossett, Taco.

### 2.2 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting.
- B. Materials:
  - 1. Pump Volute: Cast iron, with 125 pound ANSI flanged pump connections.
  - 2. Impeller: Stainless Steel.
  - 3. Shaft: Alloy steel copper sleeve.
  - 4. Mechanical Seal Assembly: Carbon brass trim, ceramic seat.
- C. Performance:
  - 1. As scheduled.
  - 2. Maximum working temperature: 230 degrees F.
  - 3. Maximum working pressure: 145 psig.

- D. Electrical Characteristics:
  - 1. As scheduled.
  - 2. 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.
- E. Manufacturers: Grundfos, Armstrong, Bell and Gossett, Taco.

### **2.3 VERTICAL IN-LINE PUMPS**

- A. Type: Single stage, single suction, split coupled, vertical in-line pump with inverter duty motor for VSD operation.
- B. Materials:
  - 1. Pump Body: Cast iron, with 125 psig ANSI flanged connections.
  - 2. Impeller: Stainless Steel.
  - 3. Bearings: Sleeve, Oil Lubricated.
  - 4. Shafts: Stainless steel.
  - 5. Mechanical Seal Assembly:
    - a. Stationary face: Carbon.
    - b. Rotating face: Tungsten Carbide.
- C. Performance:
  - 1. As scheduled.
  - 2. Maximum working temperature: 230 degrees F.
  - 3. Maximum working pressure: 145 psig.
- D. Electrical Characteristics:
  - 1. As scheduled.
  - 2. 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.
- E. Manufacturers: Grundfos, Armstrong, Bell and Gossett, Taco.

### **2.4 SUCTION DIFFUSER**

- A. Cast or ductile iron, threaded or flanged construction.
- B. Flows straightening diffuser cylinder with 3/16 inch perforations with free area at least 5 times pump opening area and a length at least 2-1/2 times the pump opening area.
- C. 16 mesh throwaway startup strainer.
- D. Support foot fitting.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protection:
  - 1. Cover pumps and plug piping connections to protect pumps from construction dirt and debris.
- B. Preparation:
  - 1. Prior to installation of pumps, verify that electrical power is available and of the same voltage and phase characteristics as the pump being installed.

### **3.2 INSTALLATION**

- A. Install pumps, pump supports, suction guides, mechanical seal piping, pressure gauges and other pump appurtenances in accordance with the manufacturer's written installation instructions.
- B. Provide access space around pumps for service. Provide no less than the minimum as recommended by manufacturer.

- C. 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.
- D. Provide line sized shut-off valve on pump suction, and line sized soft seat check valve.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals, piped to and discharging into floor drains.
- G. Provide gauges with connections to suction and discharge.
- H. Check, align, and certify alignment of base mounted pumps prior to start-up.
- I. Install close coupled and base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place.
- J. Lubricate pumps before start-up.

### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Coordinate and sequence installation of pumps and appurtenances with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Manufacturer's Field Services:
  - 1. After completion of the installation, a qualified representative of the pump manufacturer shall conduct pump start-up and written certification.
  - 2. Start-up and adjust the system to within the tolerances as specified by the equipment manufacturer. Verify pump impellers rotate in the correct direction.
  - 3. Provide two hours operating instruction to authorized Department's Representative.
  - 4. Test pump operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 25 09 00 – Sequence of Operations.
  - 5. Submit a letter of certification indicating that the pump installation and start-up has been completed, that the pumps are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the Sequence of Operation is fulfilled.

### **3.6 CLEANING**

- A. After construction is completed, clean and wipe down exposed surfaces of pumps, piping and appurtenances.
- B. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

### **3.7 START-UP**

- A. Start-up and operate hydronic pumps in accordance with the manufacturer's written installation and operation manuals.

- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

**3.8 ADJUSTING**

- A. Test, adjust and balance HVAC Pumps in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

**END OF SECTION 23 21 14**

**SECTION 23 21 23**  
**MOTORS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This section describes general requirements, products and methods of execution relating to electric Motors in general and applies to Motors furnished as integral parts of equipment specified in this and other Divisions.
- B. Related Sections:
  - 1. 20 00 00 - Mechanical General Requirements
  - 2. 22 11 00 - Domestic Water Piping and Specialties
  - 3. 22 11 23 - Packaged Lift Station
  - 4. 22 14 00 - Sanitary Waste and Vent Piping
  - 5. 22 15 13 - Compressed Air Systems
  - 6. 22 40 00 - Plumbing Fixtures
  - 7. 23 11 13 - Fuel Oil Piping and Specialties
  - 8. 23 21 14 - HVAC Pumps
  - 9. 23 34 00 - Fans
  - 10. 23 35 00 - Industrial Ventilation Systems
  - 11. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 12. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 13. 23 64 00 - Packaged Water Chillers
  - 14. 23 70 00 - Central Air Handling Units
  - 15. 23 72 13 - Dedicated Outside Air Units
  - 16. 23 81 00 - Storage Vault HVAC Equipment
  - 17. 23 81 16 - Room Air-Conditioning Units
  - 18. 23 82 00 - Terminal Heating and Cooling Units
  - 19. 23 83 00 - Radiant Floor Heating Equipment
  - 20. 23 83 01 - Snow Melting Equipment
  - 21. 25 50 00 - Building Automation and Control
  - 22. 25 55 00 - Variable Speed Drives

**1.2 REFERENCES**

- A. Codes:
  - 1. International Energy Conservation Code (IECC).
  - 2. NFPA 70, National Electric Code (NEC).
- B. Standards:
  - 1. National Electrical Manufacturers' Association - NEMA.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 20 00 00 - Mechanical General Requirements.
- B. Provide a tabular listing of Motors including the following information:
- C. Tag (from drawings), location, function, actual nameplate FLA, fuse size used, overload relay used, and overload setting. Make copy of list available during Substantial Completion observation by the Department's Representative. Include list in Operations and Maintenance Manuals.

**1.4 QUALITY CONTROL**

- A. Motors shall conform to governing NEMA Standards and ASA Form C-50 for rotating machinery.

**PART 2 - PRODUCTS**

**2.1 SUPPLY VOLTAGE**

- A. Supply voltage shall be determined from the electrical plans where nominal utility voltage will be indicated.
- B. Motor voltage shall be stamped on the nameplate and relate to the nominal voltage as follows

THREE PHASE Motors	
Nominal Volts	Motor Ratings
208 volts	200V, 208V, or 208/220V
240 volts	220V or 208/220V
480 volts	460V

SINGLE PHASE Motors	
Nominal Volts	Motor Ratings
120 volts	115V or 115/230V
240 volts	230V or 115/230V
208 volts	200V or 208V

Note: Provide nameplate indicating that voltage for motor operating at 208 VAC is suitable.

- C. Provide two sets of windings for two speed Motors.
- D. Voltage variation: Motors shall be designed to operate within the parameters of these requirements at rated load and with a voltage variation from the name plate voltage of plus or minus ten percent.
- E. Motors shall operate successfully at rated load with a combined maximum variation in the voltage and frequency of five percent above or below rated voltage and rated frequency.
- F. Motors that operate with Variable Speed Drive (VSD) controllers shall be suitable for the application.
  - 1. Motors operated using PWM type VSDs: Conform to NEMA MG 1 Part 31 requirements.
  - 2. Motors operated using six-step type VSDs: Conform to NEMA MG 1 Part 30 or Part 31 requirements.

**2.2 LOCKED ROTOR CURRENT**

- A. No motor above 15 HP shall have a locked rotor current in excess of NEMA code letter "G". Smaller Motors may have a higher locked rotor rating, but in no case exceeding the recommended NEMA rating as related to motor size.

**2.3 MOTOR INSULATION**

- A. Unless otherwise specified, motor insulation shall be NEMA Class "B" (or better). Based on 40 degrees C. maximum ambient, and 90 degrees C. maximum rise, total maximum operating temperature shall not exceed 130 degrees C.

**2.4 MOTOR LOADING**

- A. No Motors shall be subjected to loads exceeding the motor nameplate rating, under any normal operating condition.

**2.5 MOTOR RATING**

- A. Motors are sized in conformity with the manufacturer's published information and shall not be interpreted as the final requirement. Check each motor for adequacy in relation to the specific application.
- B. Motors indicated as being connected to Variable Speed Drives (VSD) shall be rated for VSD service.

**2.6 HIGH EFFICIENCY AC MOTORS**

- A. Furnished high efficiency electric Motors for equipment that:
  - 1. Require a three horsepower or larger drive motor.
  - 2. Have duty cycles classified as continuous.
- B. Efficiency of the Motors shall be determined by NEMA Standard MG 1 - 12.536 and shall have efficiencies equal to or better than:

Motor Size	Nominal Efficiency
Through 3 HP	89 percent
Over 3 HP through 10 HP	91 percent
Over 10 HP through 30 HP	93 percent
Over 30 HP through 60 HP	94 percent
Over 60 HP through 100 HP	95 percent
Over 100 HP	95 percent

**2.7 MOTOR HOUSING FEATURES**

- A. Open drip-proof, totally enclosed fan cooled (TEFC), or explosion-proof, as appropriate for the use intended and the environment where installed, or as noted. Provide totally enclosed fan cooled Motors for equipment below grade, located outdoors, or operating in damp or dust-laden locations. Provide a continuous moisture drain that is screened against insect entry for totally enclosed Motors.
- B. Oversize external conduit boxes at least one size larger than NEMA standard.

**2.8 CAPACITORS**

- A. For continuous duty-cycle Motors 40 horsepower and larger, provide capacitors sized to raise the power factor to between 95 and 98 percent at full load. Capacitors shall be enclosed, fused, and be complete with discharge resistors. Connect capacitors on the motor side of motor overcurrent protection and switch with motor.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. Installation of Motors shall be as required by the driven equipment. Ensure motor design and characteristics are suitable for the application.
- B. Electrical connections for Motors shall conform to NEC, State and local codes.

- C. Unless furnished as part of a complete package including Disconnects and control, and/or motor fuse protection, protect Motors by Bussmann Fusetron Dual-Element Time Delay fuses, or approved equal.
- D. Megger motor windings prior to starting. Include log of megger readings in the Operations and Maintenance manuals.
- E. Verify correct rotation of Motors.
- F. Comply with National Electrical Code for installation of power factor correction capacitors.
- G. Motor sizes shown on the Drawings are estimates based upon the mechanical design. Where Motors actually furnished are of a different size than those shown, motor circuit components (starters, Disconnects, overcurrent devices, and conductors) shall be revised to suit the Motors actually furnished, without increase in the Contract amount. Similarly, motor overcurrent device sizes shown on the Drawings or specified are based upon estimated motor code letters, overcurrent device manufacturers' recommendations, and full-load currents from the NEC Tables. Where the Motors actually furnished require different sizing, the sizes of the overcurrent devices shall be adjusted to conform to the NEC, without increase in the Contract amount.

**END OF SECTION 23 21 23**

**SECTION 23 31 00**  
**DUCTS AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Metal Ductwork and Fittings.
  - 2. Flexible Ductwork.
  - 3. Acoustical Linings.
  - 4. Casings and Plenums.
  - 5. Fume hood (FH) exhaust ductwork.
  - 6. Volume Dampers.
  - 7. Orifice Plates
  - 8. Control Dampers.
  - 9. Smoke and Combination Fire/Smoke Dampers.
  - 10. Fire Dampers.
  - 11. Gravity Backdraft Dampers.
  - 12. Duct silencers.
  - 13. Flexible Duct Connectors.
  - 14. Access Panels and Doors.
  
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 20 07 00 - Mechanical Insulation
  - 7. 23 05 93 - Testing, Adjusting and Balancing
  - 8. 23 34 00 - Fans
  - 9. 23 35 00 - Industrial Ventilation Systems
  - 10. 23 36 00 - Air Terminal Units
  - 11. 23 37 00 - Air Outlets and Inlets
  - 12. 23 40 01 - Duct Cleaning
  - 13. 23 70 00 - Central Air Handling Units
  - 14. 23 81 00 - Storage Vault HVAC Equipment

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. International Mechanical Code (IMC).
- C. SMACNA HVAC Duct Construction Standards – Metal and Flexible, Second Edition 2005.
- D. SMACNA HVAC Air Duct Leakage Test Manual, First Edition 1985.
- E. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
- F. National Air Duct Cleaners Association (NADCA) Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components, 1992-01.

**1.3 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.

- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
- C. Shop Drawings:
  - 1. Provide scaled ventilation system shop drawings which incorporates the following installation information:
    - a. Clearly show ductwork, joint connections and fittings. Label duct sizes using the same labeling method as the Contract Documents.
    - b. Show wall, floor, and ceiling penetrations.
    - c. Show terminal equipment ductwork connections.
    - d. Casings and plenums:
      - 1). Submit detailed shop drawings clearly showing the proposed plenum and casing materials to be used and the construction method.
      - 2). Provide a letter from the fabricator stating that the proposed construction materials and method meets the construction and performance requirements of SMACNA HVAC Duct Construction Standards – Metal and Flexible.
      - 3). Provide a letter accepting sole responsibility for compliance with patent requirements and holding the Department's Representative harmless from any claimed patent infringement(s).
- D. Installation, Operation and Maintenance (IO&M) Manuals: Not required.

#### **1.4 QUALITY CONTROL**

- A. Qualifications:
  - 1. Product Manufacturers: Minimum five (5) years manufacturing of commercial HVAC duct work and related products in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
  - 2. Installers: Minimum five (5) years experience in the installation of commercial HVAC ductwork and related products in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
- B. Pre-Installation Meetings: Coordinate installation of ductwork with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any ductwork.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Acceptance at Site:
  - 1. Verify that products are delivered to the site, free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

#### **1.6 WARRANTY**

- A. See to Section 20 00 00 - Mechanical General Requirements for general mechanical warranty requirements.

**PART 2 - PRODUCTS**

**2.1 GENERAL SHEETMETAL DUCTWORK AND FITTINGS**

- A. General:
  - 1. Provide metal ductwork and fittings fabricated in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
- B. Medium Pressure/Velocity Ductwork:
  - 1. Provide medium pressure/velocity ductwork at the following locations:
    - a. VAV ventilation systems from air handler cabinet discharge plenum connection to VAV terminal unit inlet neck connection.
  - 2. Duct Pressure Class: 3 inch WC.
  - 3. Seal Class: A.
  - 4. Maximum Velocity: 2,200 FPM.
- C. Low Pressure/Velocity Ductwork:
  - 1. Provide low pressure/velocity ductwork at the following locations:
    - a. VAV terminal unit discharge connections to air outlet connections.
    - b. Outside air intake ductwork.
    - c. Exhaust and relief air ductwork.
    - d. Constant volume ventilating systems.
  - 2. Duct Pressure Class: 2 inch WC.
  - 3. Seal Class: A.
  - 4. Maximum Velocity: 1,500 FPM.
- D. Casings and Plenums:
  - 1. Consider ductwork with any dimension exceeding 72 inches to be a plenum.
  - 2. Provide plenums as specified for Plenums and Casings.

**2.2 FLEXIBLE DUCTWORK**

- A. Performance:
  - 1. Positive Pressure Rating:
 

Ten inches WC	(4"-12" ID).
Six inches WC	(14"-16" ID).
Four inches WC	(18"-20" ID).
  - 2. Negative Pressure Rating:
 

One inch WC	(4"-12" ID).
One half inch WC	(14"20" ID).
  - 3. Maximum Velocity: 5000 FPM.
  - 4. Operating Temperature Range:
    - a. Minus 20 degrees F to 200 degrees F (continuous).
    - b. Minus 20 degrees F to 250 degrees F (intermittent).
  - 5. Insulating Value: R-4.2.
- B. Description:
  - 1. UL listed, Class 1 flexible ductwork in accordance with NFPA 90A.
  - 2. Bi-directional, ravel resistant, reinforced metalized vapor barrier.
  - 3. Acoustically rated black CPE core permanently bonded to coated spring steel wire helix.
  - 4. Fiberglass insulation.
- C. Manufacturers:
  - 1. Thermaflex, Model M-KE (Basis of Design).
  - 2. Hart & Cooley.
  - 3. JPI.

### 2.3 FUME HOOD (FH) AND SNORKEL (SKL) BRANCH EXHAUST DUCTWORK

- A. Eighteen (18) gauge, welded, 304 or 316 stainless steel ductwork and fittings from equipment connection collar to and including main exhaust truck branch tee fitting.
- B. Provided gasketed flanged connections for associated branch exhaust air valves (EAVs).

### 2.4 GENERAL LABORATORY EXHAUST DUCTWORK

- A. Provide welded stainless steel exhaust ductwork and fittings until the general lab exhaust air flow rate volume is equal to at least 50% of the total exhaust flow rate volume within a common manifold exhaust trunk.
- B. When the general lab exhaust air exceeds 50% of the total exhaust flow rate volume within a common manifolded exhaust duct, galvanized sheet metal ductwork and fittings similar to Article 2.1 may be used. Flexible laboratory exhaust ductwork is not allowed.

### 2.5 ACOUSTICAL LININGS

- A. Description:
  - 1. UL listed.
  - 2. NFPA 90A compliant.
  - 3. One inch thick, 1.5 PCF, flexible, edge-coated, mat-faced glass fiber insulation bonded with thermosetting resin.
  - 4. Does not promote growth of fungi or bacteria.
- B. Performance:
  - 1. Maximum Velocity: 6000 FPM.
  - 2. Operating Temperature Range: Up to 250 degrees F.
  - 3. Water Vapor Sorption: Less than three (3) percent.
- C. Acoustically Lined Duct Dimensions:
  - 1. Dimensions indicated are net free-area duct dimensions.
  - 2. Add twice the liner thickness to obtain actual duct dimensions.
- D. Manufacturers:
  - 1. Knauf, Model: E - M (Basis of Design).
  - 2. Armacell.
  - 3. Owens-Corning.

### 2.6 CASINGS AND PLENUMS

- A. General:
  - 1. Provide packaged air handling unit casings and plenums fabricated by the air handling unit manufacturer.
  - 2. Provide factory pre-fabricated or field fabricated plenums and casings in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, Chapter 6.
- B. Specific Double-Walled Casing and Plenum Requirements:
  - 1. Outer duct: Galvanized steel (20 gauge, minimum).
  - 2. Liner: Perforated, galvanized steel (22 gauge minimum.).
  - 3. Insulation:
    - a. Standard 2-inch fiberglass insulation with Mylar or similar cover material to prevent dust accumulation and to prevent insulation from entering the air stream.
    - b. Provide 4-inch insulation where indicated.
  - 4. Access Doors:
    - a. Provide access doors in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, Chapter 6.

5. Acoustical Performance Sound Transmission Losses (dB):

BAND, HZ	125	250	500	1000	2000	4000
2" Wall Thickness	18	21	29	38	49	55
4" Wall Thickness	16	24	35	45	53	58

**2.7 VOLUME DAMPERS**

- A. General Construction:
1. Refer to SMACNA HVAC Duct Construction Standards – Metal and Flexible for fabricated damper construction requirements.
  2. Round ducts to 12 inches diameter and rectangular to 6 inches blade width:
    - a. Flat sheet, galvanized steel, single leaf damper.
    - b. Provide damper leaf which is two gauges thicker than the duct gauge at the location installed.
    - c. Continuous steel rod.
  3. Round ducts over 12 inches diameter:
    - a. Square damper with casing, unless otherwise indicated.
  4. Rectangular ducts larger than six inches:
    - a. Opposed blade damper with blades mounted in separate channel frame installed inside duct.
  5. Accessible and lockable damper operators.
- B. Extractors: Not Permitted.
- C. Splitter Dampers: Not Permitted.
- D. Manufacturers:
1. Ruskin (Basis of Design).
  2. Greenheck.
  3. Approved equal.

**2.8 REMOTE VOLUME DAMPER OPERATORS**

- A. Provide flush mounted chrome plated remote operators with tamperproof cover, extension rod, and not more than one 90 degree angle gear drive.
- B. Regulator: Duro-dyne Series SRC-380 or Young Regulator 301.
- C. Angle Drive: Duro-dyne Model AD-38 or Young Regulator 927.
- D. Manufacturers:
1. Duro-dyne.
  2. Young Regulator.
  3. Approved equal.

**2.9 ORIFICE PLATES**

- A. General Construction:
1. Refer to SMACNA HVAC Duct Construction Standards – Metal and Flexible for duct fabrication and installation requirements.
- B. Method:
1. Provide duct sleeve with raised rib (SMACNA Fig. 3-8 G) which matches duct diameter at indicated orifice plate location.
  2. Provide round blank flat plate one gauge thicker than sleeve gauge thickness.
  3. Flat plate diameter shall be slightly larger than general sleeve I.D., but slightly less than sleeve rib I.D.

4. Punch orifice hole through center of disk with diameter as detailed.
5. Slightly bend orifice plate and "pop" into place in sleeve rib. Temporarily duct tape orifice plate in place to prevent perimeter leakage.
6. Balance system. See Section 23 05 93 – Testing, Adjusting and Balancing.
7. Adjust orifice hole size as necessary to match short branch pressure drop to critical branch (longest branch) system pressure drop.
8. Once orifice plate is properly adjusted (and recorded in TAB report), remove duct tape and apply permanent duct sealant.
9. Provide oval compression type duct access panel immediately upstream of orifice plate. Label door "ORIFICE PLATE." See Section 20 05 53 – Mechanical Identification.

## 2.10 CONTROL DAMPERS

- A. Rectangular:
  1. Frame: Five inches by one inch by minimum 0.125 inch 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.
  2. Blades: Provide airfoil-shaped, single-piece blades made of heavy-duty 6063-T5 extruded aluminum. Maximum 6 inches blade width.
    - a. Provide opposed blade type dampers for the following applications:
      - 1). Exhaust fan discharge dampers.
      - 2). Outside air intake dampers.
    - b. Provide parallel dampers for the following applications:
      - 1). Air handling unit mixing box.
  3. Bearings: Molded synthetic sleeve, turning in hole in frame.
  4. Seals:
    - a. Blade: Extruded vinyl type for ultra-low leakage from minus 50 degrees F. to plus 350 degrees F. Mechanically attached to blade edge.
    - b. Jamb: Flexible metal compression type.
  5. Linkage: Concealed in frame.
  6. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade.
  7. Finish: Mill aluminum.
  8. Performance Data:
    - a. Temperature Rating: Withstand minus 50 degrees F. to plus 350 degrees F.
    - b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
      - 1). Closed Position: Maximum pressure of 13 inches W.C. at a 12-inch blade length.
      - 2). Open Position: Maximum air velocity of 6,000 feet per minute.
    - c. Leakage: Maximum 2.0 cubic feet per minute per square foot at 1.0 W.C. for sizes 24 inches wide and above.
    - d. Pressure Drop: Maximum 0.03 inches W.C. at 1,500 feet per minute across 24 inch by 24 inch damper.
  9. Manufacturer: Ruskin, Model CD50, Greenheck, Air Balance, Pottorff, or pre-approved equal.
- B. Round:
  1. Frame:
    - a. Under 6 inches Diameter: Two inches by minimum 12 gauge galvanized steel tube.
    - b. 6 through 12 inches Diameter: Two inches by 1/2 inch by minimum 14 gauge galvanized steel channel.
    - c. Above 12 through 24 inches Diameter: Two inches by 1/2 inch by minimum 1/8 inch galvanized steel channel.
    - d. Above 24 inches Diameter: Two inches by one inch by minimum 3/16 inch galvanized steel channel.

2. Blade: Provide single-piece construction made of the following material:
  - a. 18 inches diameter and less: Minimum 12 gauge galvanized steel.
  - b. Over 18 inches diameter: Minimum 10 gauge galvanized steel, stiffeners as required.
3. Blade Seals: Closed cell polyethylene foam rubber fully encompassing and mechanically attached to blade edge.
4. Bearings: Self-lubricating stainless steel sleeve.
5. Axles:
  - a. 22 inches Diameter and less: Minimum 1/2 inch diameter, full length, plated steel, mechanically attached to blade.
  - b. Over 22 inches Diameter: Minimum 3/4 inch diameter, full length, plated steel, mechanically attached to blade.
6. Finish: Mill galvanized.
7. Performance Data:
  - a. Temperature Rating: Withstand maximum 250 degrees F.
  - b. Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
  - c. Closed Position: Maximum pressure of 10 inches W.C.
  - d. Open Position: Maximum air velocity of 4,000 feet per minute /min.
  - e. Leakage: Maximum 10 cubic feet per minute total at 1 inch W.C.
  - f. Pressure Drop: Maximum 0.05 inch W.C. at air volume of 7,000 cubic feet per minute through 24 inch diameter damper.
8. Manufacturer: Ruskin Model CDR25, Greenheck, Air Balance, Pottorff, or approved equal.

**2.11 SMOKE DAMPERS AND COMBINATION FIRE / SMOKE DAMPERS**

A. General:

1. UL listed and labeled in accordance with standard UL Standard 555S.
2. Combination Fire/Smoke dampers also listed in accordance with UL Standard 555 for 1-1/2 hour rating.
3. Temperature resistance classification: 250 degrees F.
4. Leakage classification: Type II.

Leakage Classifications	
"O" =	0 CFM/SF (Imaginary)
"I" =	4 CFM/SF (Superb)
"II" =	10 CFM/SF (Excellent)
"III" =	40 CFM/SF (Good)
"IV" =	60 CFM/SF (Ordinary Control Damper)
At 1-inch water column differential and not more than twice listed value at 4 inches water column.	

B. Damper Actuators:

1. Supply damper actuators as part of the listed damper assembly. If the damper actuators must be provided separately, actuators must be UL listed for a temperature classification greater than or equal to the temperature classification of the damper.
2. Provide damper actuators powered by 120 VAC; energized in the normal open position and spring driven shut on loss of power. See Section 28 31 13 – Addressable Fire Alarm System for sequences of operation.
3. Provide thermal actuation of combination fire/smoke dampers by a UL listed electric temperature-sensing device with manual remote reset capability from the fire alarm system.

- C. Manufacturers:
  - 1. Ruskin (Basis of Design).
  - 2. Greenheck.
  - 3. ACME Engineering and Manufacturing Corp.
  - 4. Approved equal.

## 2.12 FIRE DAMPERS

- A. General:
  - 1. UL listed and labeled in accordance with standard UL Standard 555.
  - 2. Fire Ratings suitable for the applicable wall construction ratings in accordance with IBC.
  - 3. Minimum fire rating: 1-1/2 hour.
- B. Damper Blades:
  - 1. Low pressure/velocity ductwork: Folding blade type with blades located out of air stream, except where specifically shown.
  - 2. Medium pressure/velocity ductwork: Dynamic folding blade type with blades located out of air stream. Spring operation for positive damper closure.
- C. Manufacturers:
  - 1. Ruskin (Basis of Design).
  - 2. Greenheck.
  - 3. ACME Engineering and Manufacturing Corp.
  - 4. Pottorff.
  - 5. Approved Equal.

## 2.13 GRAVITY BACKDRAFT DAMPERS

- A. General:
  - 1. Maximum fully open static pressure drop: 0.10-inch WC (maximum).
  - 2. Metal damper blades metal with felt edges. Provide neoprene edged blades where dampers are exposed to outside temperatures.
  - 3. Rigid steel damper frames with bronze or nylon type bearings.
- B. Manufacturer:
  - 1. Ruskin (Basis of Design).
    - a. Model: CBS-4, (BD2/A1 or CBS-8 as applicable).
  - 2. Greenheck.
  - 3. Approved equal.

## 2.14 COUNTERBALANCED BACKDRAFT DAMPERS

- A. General:
  - 1. 6" horizontal extruded alumni blades with vinyl edge seals mechanically interlocked to blade.
  - 2. Corrosion resistant steel frame, linkages and axles with synthetic bearings.
  - 3. Adjustable opening pressure .01" to .06"
  - 4. Manufacturer:
  - 5. Ruskin (Basis of Design) Model: CBD).
  - 6. Greenheck.
  - 7. Approved equal.

## 2.15 DUCT SILENCERS

- A. Provide duct silencers of the size and with the performance as scheduled. Locate duct silencers as shown.
- B. Performance of silencers including dynamic insertion loss, self-noise and pressure loss shall be determined by the manufacturer and certified in accordance with ASTM Standard E477-96

or later issue. Compliance with ADC Standard 1062R3 is also required, except where this would result in lower performance than ASTM E-477.

- C. Silencer requirements shall not be reduced from specified attenuation.
- D. Construction:
  - 1. "Clean Air" type except on exhaust systems and shall not have acoustic infill material in direct contact with the air stream.
  - 2. Constructed from galvanized steel with solid outer shell and a polymer sheeting/bagging or solid metal liner to contain the mineral fiber absorption material.
  - 3. Polymer sheeting/bagging separated from the air stream with perforated sheet metal. The perforated sheet metal shall be separated from continuous, direct contact with the film to prevent premature wear and fatigue of the film.
  - 4. The outer shell shall at least equal SMACNA requirements for the positive or negative static pressure at the point of application. Interior surfaces shall be smooth and streamlined.
- E. Basis of Design duct silencers selected with regard to practical limits of pressure loss and self-noise.
- F. Silencers with duct connections generally have a larger cross-section than the upstream or downstream ducts.
- G. Air transfer silencers through acoustical or fire rated walls are selected for a static pressure loss not exceeding 0.06 inches water column unless otherwise indicated.
- H. Substitutions or changes proposed by the Contractor shall be selected in accordance with the above considerations.
- I. Manufacturers:
  - 1. IAC (Basis of Design).
  - 2. Rink.
  - 3. United McGill.
  - 4. Commercial Acoustics.

## **2.16 ACCESS PANELS AND DOORS FOR DUCTS AND PLENUMS**

- A. General:
  - 1. Constructed from 24 gauge (minimum) galvanized steel.
  - 2. Reinforced doors with cross-bracing and/or otherwise stiffened to prevent rattling and vibration.
  - 3. Provide rubber gaskets, secured to door or frame.
  - 4. Where ductwork is insulated or lined, provide double-walled access door panels with one (1) inch of internal insulation to match duct or plenum insulating and/or sound attenuation characteristics.
  - 5. Walk Through Doors:
    - a. Construct in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
    - b. Provide insulation and inner liner to match plenum or casing.
- B. Hinges and Latches:
  - 1. Low velocity system access panels:
    - a. Sizes six inches by six inches through 24 inches by 24 inches.
    - b. Continuous steel hinge mechanically fastened to frame and quarter turn cam latches.
  - 2. Medium velocity system access panels:
    - a. Sizes six inches by six inches through 24 inches by 24 inches.
    - b. Continuous steel hinge mechanically fastened to frame.
    - c. Provide a minimum of two latches for rolled plate doors.
    - d. Cement sheet rubber gasket to door.

3. Walk through doors (any dimension over 24 inches):
  - a. Provide three hinges and two latches with inside and outside handles.
- C. Manufacturers:
  1. Air Balance Inc. (Basis of Design).
    - a. Model: FSA-100.
  2. Approved equal.

## 2.17 FLEXIBLE FAN/DUCT CONNECTORS

- A. Fan Connectors:
  1. Provide fan connectors with static pressure ratings suitable for each specific application. Minimum pressure ratings must be greater than, or equal to, the Fans shut-off static pressure, as indicated by the submitted fan curve, with a fifty (50) percent safety factor.
- B. Duct Joints:
  1. Provide flexible duct connector for each duct that passes through building seismic joints.
  2. Field fabricate flexible duct connector galvanize steel edges with additional galvanized steel sheet stock to form flanged duct connections. Connect flexible connectors to hard duct with mating, gasketed, flange fittings.
- C. Materials:
  1. Metal edging: 24 gauge galvanized steel.
  2. Fabric: UL Listed, nylon/polyester blend with vinyl coating. Double folded seams.
    - a. Fan connectors: Four (4) inch fabric width.
  3. Duct Joint: Size width of flexible fabric to withstand design seismic joint offset with a fifty (50) percent safety factor.
- D. Manufacturers:
  1. Duro-dyne Corporation (Basis of Design)/ Dynalon.
  2. Vent Fabrics.
  3. Approved equal.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify location, size and type (i.e. fire resistive construction) of wall, floor and ceiling/roof penetrations.

### 3.2 PREPARATION

- A. Protection:
  1. During construction, install temporary closures of sheet metal, cardboard or polyethylene taped over ductwork openings to prevent construction dust and debris from entering duct systems.

### 3.3 INSTALLATION

- A. Metal Ductwork and Fittings:
  1. Install, seal and support ductwork and fittings in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible for the duct pressure class and seal class specified. The use of “duct tape” as a duct seal method is prohibited.
  2. Proprietary or other joint systems may be substituted for SMACNA details when submitted and approved in writing before starting work.
  3. Sleeve acoustical duct penetrations through full walls perpendicular to wall surface. Provide 1/2” minimum gap between sleeve and duct. Fill gap with mineral wool backer and seal each side of penetration with acoustical sealant.
  4. Where ducts penetrate through walls into occupied spaces, provide sheet metal escutcheons at each penetration to provide a clean, finished appearance.

5. Seal duct penetrations of fire resistive construction by methods equivalent to those specified for piping in Section 20 05 29 – Supports and Hangers.
  6. Provide required duct accessories in accordance with Section 23 31 00 – Ducts and Accessories.
  7. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoffs, use 90-degree conical tee or low-loss tee connections.
  8. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream of equipment.
  9. Provide orifice plates at branch connections as required for proper ventilation system balancing. Select orifice installation method to limit noise from mechanical vibration or air bypass.
  10. Do not use turning vanes or manual balancing dampers in medium velocity duct systems.
  11. Support duct mounted equipment, equal to, or greater than 40 pounds, such as heating coils, independently from ductwork.
  12. Support duct mounted equipment less than 40 pounds, using standard duct supports and sway bracing located within 12 inches of equipment.
  13. Where offsetting ductwork is not possible, ducts may be reduced a maximum of 20 percent to clear obstacles with Department's Representative's permission.
  14. Where steel ductwork is visible through air outlets or return/exhaust grilles, paint visible interior ductwork flat black.
  15. Install flanged flexible duct connectors where ducts pass through seismic building joints. Support hard duct from structure on each side of the seismic joint such that the flexible connector is aligned with duct run and bears no load. Locate joint within the vertical plane of the seismic joints.
- B. Flexible Ductwork:
1. Install, connect and support flexible ductwork in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible
  2. Connection to air outlets in suspended grid ceiling systems: Provide a flexible duct length of 8 to 10 feet with one 90-degree bend or large radius 180-degree curve in addition to outlet connection. Support flexible duct at connections to air outlets to maintain minimum recommended bend radius.
  3. Seal flexible duct connections to rigid ductwork with draw bands to the pressure class of the rigid duct system.
  4. Flexible duct connections between medium pressure ductwork and Air Terminal Units are prohibited.
  5. Flexible ductwork is prohibited in inaccessible locations, such as above "hard" ceilings.
  6. Flexible ductwork is prohibited at penetrations through walls.
- C. Acoustical Ductwork:
1. Provide standard one inch thick acoustically lined ductwork as indicated using the acoustical liner material specified. Attach the lining material to the ductwork in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
  2. Provide thicker acoustically lined ductwork where specifically noted.
  3. Dimensions indicated are net inside duct dimension. Add twice the liner thickness to obtain metal sizes.
  4. Sleeve acoustical duct penetrations through full walls perpendicular to wall surface. Provide 1/2" minimum gap between sleeve and duct. Fill gap with mineral wool backer and seal each side of penetration with acoustical sealant.
- D. Casings and Plenums:
1. Install casings and plenums in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
  2. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.

3. Casings: Unless indicated otherwise, install floor mounted casings on 4 inch high concrete curbs.
  4. At floor, rivet panels on 8 inch centers to steel angles. Where floors are acoustically insulated, furnish 18 gauge galvanized expanded metal mesh liner supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- E. Volume Dampers:
1. Provide air volume dampers at each low-pressure duct main and branch take-off for proper air balancing.
  2. Locate dampers a minimum of 10 feet from diffusers except where clearly shown otherwise.
  3. Volume dampers are not to be installed in medium pressure, variable air volume systems.
- F. Orifice Plates:
1. In medium pressure systems where large variations exist in system pressure drop between separate branch duct systems serving the same central air handler, provide orifice plates balance branch pressure drops. Coordinate orifice locations during shop drawing preparation as required.
- G. Fire, Smoke and Combination Fire/Smoke Dampers:
1. Before starting work, verify the location and types of fire resistive construction as indicated by the Contract Drawings. Typical fire rated separations include:
    - a. Area separation walls, vertical only.
    - b. Occupancy separation walls, or partitions and floors. Vertical or horizontal.
    - c. Fire resistive egress corridors, halls and vestibules.
    - d. Fire resistive enclosures of hazardous spaces within an occupancy, including rooms for fuel-fired or electric heating equipment.
    - e. Fire resistive floor/ceiling assemblies associated with any of the above.
  2. Verify locations and types of dampers indicated on drawings. If dampers appear to be incorrectly located or missing, obtain clarification from Department's Representative.
  3. Install dampers at locations indicated on the Drawings and in accordance with manufacturer's UL approved installation instructions.
  4. Install round dampers round and free from racking. Install rectangular dampers square and free from racking.
  5. Do not compress or stretch damper sleeve into duct or opening.
  6. Handle damper using frame/sleeve. Do not lift damper using blade, actuator, or jackshaft.
- H. Gravity Backdraft Dampers:
1. Provide heavy duty, balanced, backdraft dampers at each building exhaust or relief location where a motor operated control damper is not indicated.
  2. Provide backdraft dampers in addition to motor operated control dampers, as indicated.
  3. Locate backdraft dampers in the curb opening of roof curb mounted exhaust Fans.
  4. Locate the backdraft damper in the discharge duct immediately upstream of the exhaust louver or hood for Fans located within building.
  5. Double leaf butterfly dampers in roof outlets are permissible only for paint booths and similar applications.
- I. Flexible Duct Connectors:
1. Install duct connectors in accordance with the manufacturers written installation instructions.
  2. Provide a flexible airtight joint between Fans and other vibrating equipment and the air distribution ductwork systems.
  3. Externally isolated air handling units and Fans: Provide flexible connections where ducts attach to unit inlet and outlet(s) of unit.

- J. Access Panels and Doors:
  - 1. Locate access doors to enable in-duct equipment to be easily inspected, cleaned, maintained and tested and/or reset.
  - 2. Provide access doors at the following locations:
    - a. Fire dampers.
    - b. Combination fire/smoke dampers.
    - c. Smoke dampers.
    - d. Motor operated dampers.
    - e. Each side of duct mounted heating and cooling coils.
    - f. Each side of duct mounted humidification dispersion panels.
    - g. As necessary for Duct Cleaning in accordance with NADCA Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components.
    - h. As necessary for maintenance access to serviceable instrumentation and control equipment.
  - 3. Coordinate location and size of access doors in walls, partitions and ceilings to correspond with duct access doors, volume dampers and automatic control devices and instruments.
  - 4. Coordinate with supplier of component air handlers, package units and similar equipment to ensure that access doors and panels will not be obstructed when the equipment is installed.

### **3.4 INTERFACE WITH OTHER WORK:**

- A. Coordinate the routing of ducts with other trades to avoid interference with other building features.
- B. Assist electrical and controls trades in mounting instrumentation devices and safety controls in ductwork and air handling units.
- C. Provide support for ventilation system air balancing in accordance with Section 23 05 93 – Testing, Adjusting and Balancing.
- D. Make penetrations through exterior building walls watertight. Detail ductwork connections to prevent condensation or leakage from entering into surrounding building construction. Provide sleeves, special connections and sealant as required to accomplish this performance requirement.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Site Tests:
  - 1. Test automatic closure and reset of smoke and combination fire/smoke dampers in accordance with Section 28 31 13 – Addressable Fire Alarm System sequences of operation.
  - 2. Provide written certification to the Department's Representative that smoke and combination fire/smoke dampers have been operationally tested and function in accordance with the specified sequences of operation.
- C. Duct Pressure Test:
  - 1. Leak test stainless steel exhaust systems in accordance with SMACNA testing procedures. Repair leaks and retest as required. Document test results and submit for approval. Duct testing must be witnessed by designated maintenance personnel as directed by the Department's Representative.
- D. Inspections:
  - 1. Physically verify accessibility to ventilation system components for maintenance, adjustment and cleaning.

**3.6 ADJUSTING**

- A. Adjust and balance dampers in accordance with Section 23 05 93 – Testing, Adjusting and Balancing.

**3.7 CLEANING**

- A. Maintain ventilation system ductwork and return plenums free of construction dust and debris.
- B. Prior to building occupancy and after ventilating systems are complete and functional, verify cleanliness of ventilating system ductwork. Verification shall comply with the Visual Inspection method outlined in National Air Duct Cleaners Association (NADCA) Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components, 1992-01. Conduct inspection in the presence of a representative of the Department's Representative.
- C. If the ductwork does not comply with the standard for cleanliness, clean the affected ductwork and equipment in accordance with Section 23 40 01 – Duct Cleaning.

**END OF SECTION 23 31 00**

**SECTION 23 34 00**  
**FANS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. In-line cabinet fans.
  - 2. In-line centrifugal fans.
  - 3. Roof exhausters.
  - 4. Roof curbs.
  - 5. Sidewall propeller fans.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 20 07 00 - Mechanical Insulation
  - 7. 23 05 93 - Testing, Adjusting and Balancing
  - 8. 23 21 23 - Motors
  - 9. 23 31 00 - Ducts and Accessories
  - 10. 23 40 01 - Duct Cleaning
  - 11. 25 09 00 - Sequences of Operation
  - 12. 25 50 00 - Building Automation and Control
  - 13. 25 55 00 - Variable Speed Drives

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. NFPA 70 – National Electrical Code.
- C. Air Movement and Control Association (AMCA) 99 – Standards Handbook.

**1.3 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
  - 2. Fan curves with scheduled operating point clearly plotted.
  - 3. Sound power levels (in decibels) for each octave band for inlet, discharge, and radiated sound power for the assembled fan unit. Obtain sound level data by one of the following methods:
    - a. Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
    - b. Documented calculations that start with AMCA tested fan sound data and are modified in accordance with current ASHRAE procedures (ASHRAE HVAC Applications Handbook) to accurately predict the sound power levels for the configuration shown.
  - 4. Electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

- C. Shop Drawings:
  - 1. Provide scaled ventilation system shop drawings which incorporates the following installation information:
    - a. Fan locations.
    - b. Fan support methods as applicable.
    - c. Fan connection methods to duct systems.
- D. Installation, Operation and Maintenance (IO&M) Manuals:
  - 1. Provide copies of approved submittal information.
  - 2. Provide copies of manufacturer's written installation, operation and maintenance manual, clearly annotated to indicate the equipment installed. Include parts listing and spare parts list.

#### **1.4 QUALITY CONTROL**

- A. Qualifications:
  - 1. Product Manufacturers: Minimum five (5) years manufacturing of commercial HVAC Fans and related equipment in accordance with AMCA standards.
  - 2. Installers: Minimum five (5) years experience in the installation of commercial HVAC fan systems.
- B. Pre-Installation Meetings: Coordinate installation of ductwork with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any ductwork.
- C. Regulatory Requirements:
  - 1. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., or by a testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Acceptance at Site:
  - 1. Verify that products are delivered to the site, free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

#### **1.6 WARRANTY**

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements.

### **PART 2 - PRODUCTS**

#### **2.1 SMALL CABINET FANS (SCF)**

- A. Galvanized or enamel painted steel housing with one inch acoustical lining. Hinged gasketed access door with latch.
- B. Fan statically and dynamically balanced. Internal spring mounted fan and motor assembly. Adjustable fan drive. Static free belts. Ball bearing fan and Motors. Bearings with L50 life of 200,000 hours.
- C. Heavy-duty fan motors with permanently sealed ball bearings. Ground and polished steel fan wheel shaft mounted in permanently sealed pillow block bearings. Size drives for a minimum

of 150 percent of driven horsepower. Machined cast iron type pulleys, keyed and securely attached to fan wheel and motor shafts. Adjustable motor pulleys for final system balancing.

- D. AMCA Certified Ratings Seal for air performance.
- E. Filter section for 2" pre-filter (Camfil Farr 30/30 MERV 8), maximum face velocity of 350 Feet per minute.
- F. Mixing box with opposed blade low leakage dampers with vinyl edge seals in configuration shown.
- G. Corrosion resistant fasteners.
- H. Manufacturer: Greenheck or approved equal.

## 2.2 TRANSFER FANS (TF)

- A. Duct mounted, belt driven, in-line centrifugal type Fans. Rectangular fan housing design constructed of heavy gauge galvanized steel with rectangular duct mounting collars.
- B. Hinged panel in fan cabinet of sufficient size to permit access for service to internal components without dismantling the cabinet.
- C. Centrifugal backward inclined fan wheel, constructed of aluminum and matched wheel and inlet cones for precise running tolerances. Dynamically and statically balanced at the factory.
- D. Heavy duty ball bearing type fan Motors, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives mounted out of the airstream and readily accessible for maintenance.
- E. Precision ground and polished fan shafts mounted in permanently sealed, lubricated pillow block ball bearings. Bearings selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed.
- F. Drives sized for a minimum of 150 percent of driven horsepower. Machined cast iron type pulleys, keyed and securely attached to fan wheel and motor shafts. Adjustable motor pulleys for final system balancing.
- G. NEMA 1 disconnect switch provided as standard, except with explosion resistant Motors, where Disconnects are optional. Factory wiring provided from motor to the handy box.
- H. AMCA Certified Ratings. Seal for both sound and air performance.
- I. Permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
- J. Manufacturers: Greenheck, Cook or Penn.

## 2.3 ROOF EXHAUSTERS (EF)

- A. Belt driven Fans with centrifugal backward inclined fan wheels, constructed of aluminum with matched wheel and inlet cones for precise running tolerances. Statically and dynamically balanced at the factory.
- B. Fan housings constructed of heavy gauge aluminum with rigid internal support structure. Fan shroud to include a rolled bead for added strength.
- C. Heavy duty ball bearing type fan Motors, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Motors and drives mounted on vibration isolators, out of the airstream. Motors readily accessible for maintenance.
- D. Drive frame assemblies constructed of heavy gauge steel and mounted on vibration isolators. Precision ground and polished fan shafts mounted in permanently sealed, lubricated pillow block ball bearings. Bearings selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives sized for a minimum of 150% of driven horsepower. Fully machined cast iron type pulleys keyed and securely attached to fan wheel and motor shafts. Motor pulleys adjustable for final system balancing.

- E. Factory installed disconnect switch and wired from the fan motor to a junction box installed within the motor compartment.
- F. Provide a fan conduit chase through the curb cap to the motor compartment for ease of installation.
- G. AMCA Certified Ratings. Seal for sound and air performance.
- H. Permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
- I. Manufacturers: Greenheck, Cook or Penn.

#### **2.4 ROOF EXHAUSTER MOUNTING CURBS**

- A. Provide pre-manufactured roof curbs compatible with the specific equipment to be mounted.
- B. Provide roof curbs from the same manufacturer as the equipment to be mounted when available. Provide pre-manufactured adapters/reducers to match equipment to roof curb dimensions as required.
- C. Pitched, ridge or flat base as necessary to match roof slope and provide a level equipment mounting surface.
- D. Provide roof curbs specifically design to match roof deck application (insulated or non-insulated roof decks).
- E. Salient Characteristics:
  - 1. Welded, 18 gage, galvanized steel construction with base cant.
  - 2. 24 inch curb height.
  - 3. Two inch thick fiberglass insulation.
  - 4. Factory installed, pressure treated wood nailer.
  - 5. Motorized or back-draft damper tray as applicable.
- F. Manufacturers:
  - 1. Greenheck.
  - 2. Ruskin.
  - 3. Approved equal.

#### **2.5 SIDEWALL PROPELLER FANS (RF)**

- A. Direct drive, axial type sidewall fans.
- B. Propellers constructed with cast aluminum blades and hubs with standard square key and set screw or tapered bushing motor shaft connection. Statically and dynamically balanced at the factory.
- C. Permanently lubricated electric motors, carefully matched to the fan load and furnished at the specified RPM, voltage, phase, and enclosure.
- D. Motor drive frame assemblies and fan panels constructed of galvanized steel. Drive frame assemblies constructed of formed channels with pre-punched mounting holes, formed flanges, and deep formed inlet venturi. Drive frames and panels shall be bolted construction.
- E. AMCA Certified Ratings. Seals for both sound and air performance.
- F. Manufacturers: Greenheck, Cook, Penn or pre-approved equal.

#### **2.6 FAN ACCESSORIES**

- A. See Section 23 31 00 – Ducts and Accessories.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection:
  - 1. Maintain fan covers and shrouds in place at all times.
  - 2. Cover fan inlets and outlets to protect components from construction dirt and debris.
- B. Surface Preparation:
  - 1. Provide clean and level housekeeping pad to support equipment as applicable.
  - 2. Provide roof penetrations and level roof curbs for roof mounted Fans.
  - 3. Coordinate penetration locations with structure.

#### **3.2 INSTALLATION**

- A. Install Fans in strict compliance with the manufacturer's written installation instructions.
- B. Support Fans independently from ductwork. Provide flexible connections at fan duct connections as applicable.
- C. Provide fan support in accordance with 20 05 29 – Hangers and Supports.
- D. Provide support and vibration isolation for suspended Fans in accordance with 13 48 00 – Sound, Vibration and Seismic Control.
- E. Coordinate installation of equipment to ensure that access doors and panels will not be obstructed when the equipment is installed.
- F. Extend lubrication points which cannot be easily reached directly as required and identified.

#### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Coordinate and sequence installation of Fans with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Department's Representative.

#### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

#### **3.5 FIELD QUALITY CONTROL**

- A. Document each fan installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

#### **3.6 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external and system components and internal shrouded areas.

#### **3.7 ADJUSTING**

- A. Test, adjust and balance Fans in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

**3.8 DEMONSTRATION & START-UP**

- A. Start-up and operate Fans in accordance with the manufacturer's written installation and operation manual check list.
- B. Demonstrate proper system operation in accordance with the Section 25 09 00 – Sequence of Operation.

**END OF SECTION 23 34 00**

**SECTION 23 35 00**  
**INDUSTRIAL VENTILATION SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Packaged saw dust collection systems.
  - 2. Process exhaust ductwork.
  - 3. Flexible wood working equipment connections.
  - 4. Blast gates.
  - 5. Floor sweeps.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00- Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 21 23 - Motors
  - 7. 23 31 00 - Ducts and Accessories
  - 8. 25 09 00 - Sequences of Operation
  - 9. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. NFPA 70 – National Electrical Code.
- C. AMCA 210 (Air Movement and Control Association) – Laboratory Methods of Testing Fans for Rating.

**1.3 SUBMITTALS**

- A. Refer to Section 20 00 00– Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
  - 2. Fan curves with scheduled operating point clearly plotted.
  - 3. Sound power levels (in decibels) for each octave band for inlet, discharge, and radiated sound power for the assembled fan unit. Obtain sound level data by one of the following methods:
    - a. Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
    - b. Documented calculations that start with AMCA tested fan sound data and are modified in accordance with current ASHRAE procedures (ASHRAE HVAC Applications Handbook) to accurately predict the sound power levels for the configuration shown.
  - 4. Electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Shop Drawings:
  - 1. Provide scaled exhaust ventilation system shop drawings which incorporates the following installation information:
    - a. Dust collector location
    - b. Duct routing, flexible connection and floor sweep locations.

- D. Installation, Operation and Maintenance (IO&M) Manuals:
  - 1. Provide copies of approved submittal information.
  - 2. Provide copies of manufacturer's written installation, operation and maintenance manual, clearly annotated to indicate the equipment installed.
  - 3. Include parts listing and spare parts list.

#### **1.4 QUALITY CONTROL**

- A. Qualifications:
  - 1. Product Manufacturers: Minimum five (5) years manufacturing of commercial HVAC Fans and related equipment in accordance with AMCA standards.
  - 2. Installers: Minimum five (5) years experience in the installation of commercial exhaust equipment.
- B. Pre-Installation Meetings: Coordinate installation of ductwork with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any ductwork.
- C. Regulatory Requirements:
  - 1. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., or by a testing firm acceptable to the Authority Having Jurisdiction as suitable for the purpose specified and indicated.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Acceptance at Site:
  - 1. Verify that products are delivered to the site, free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

#### **1.6 WARRANTY**

- A. See Section 20 00 00- Mechanical General Requirements.
- B. Provide one-year manufacturers' warranty.

### **PART 2 - PRODUCTS**

#### **2.1 PACKAGED SAW DUST COLLECTION SYSTEMS (DC-1)**

- A. Construction: Packaged, factory assembled self-contained cyclone type dust collection system installed in accordance with NFPA-664.
  - 1. Funnel bottom with 55 gallon collection drum.
  - 2. Structural steel legs to accommodate drum.
  - 3. Discharge silencer: 22 gage exterior, minimum 1.5 square feet face area, lined with 4.75 lbs/cu.ft. inorganic material or glass fiber, SIL = 5-7 DB(A), protected by perforated galvanized metal with aerodynamic edges. Meets ASTM E84 for flame spread. Provide transitions to cyclone and after-filter.
  - 4. After-filter section: Provide minimum 100 square feet of filter area, 4 filter tubes at 70 inches long with zipper bottoms and support legs.
  - 5. Fan: Integral, radial design. Construct fan wheel of aluminum. Direct drive, 480 volt, 3450 RPM TEFC fan motor.
- B. Manufacturers:
  - 1. Sternvent Company (Basis of Design).

2. American Air Filter
3. Pre-approved equal.

## 2.2 SAWDUST COLLECTION DUCTWORK

- A. Ductwork size (Diameter):
  1. Branch ductwork velocity: 4000 FPM.
  2. Main ductwork velocity: 3500 FPM
  3. Utilized odd sized ductwork to when required maintain duct velocities.
- B. Ductwork: Spiral pipe: Minimum 24 gauge galvanized steel.
- C. Fittings:
  1. Elbows/lateral and "Y" branch connections: 20 gauge galvanized steel. Die stamped or welded.
  2. Duct connectors: Easy Connection Sleeves with polyethylene seal.
  3. End cap cleanouts.
- D. Manufacturers:
  1. Air Handling Systems.
  2. Pre-approved equal.

## 2.3 FLEXIBLE CONNECTORS

- A. Provide flexible connectors to connect each piece of shop equipment, maximum 2 feet.
- B. Construction: Abrasion resistance urethane, 20-45 mm thick.
- C. Manufacturers:
  1. Sternvent CWC.
  2. Air Handling Systems MFLE.
  3. Pre-approved equal.

## 2.4 SPECIAL ATTACHMENTS

- A. Blast Gates:
  1. Provide full blast gate at branch duct to each piece of shop equipment.
  2. Construction:
    - a. Aluminum castings with a galvanized steel slide blade.
  3. Manufacturers:
    - a. Air Handling Systems.
    - b. Pre-approved equal.
- B. Floor Sweeps:
  1. Manufacturers:
    - a. Air Handling Systems.
    - b. Pre-approved equal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install, seal and support ductwork and fittings in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible for the duct pressure class and seal class specified. The use of "duct tape" as a duct seal method is prohibited.
- B. Arrange ductwork and fittings to provide a smooth path to the duct collector free of abrupt changes in direction. Utilize lateral duct connections at each equipment take-off. Increase duct sizes gradually, not exceeding 15 degrees divergence. Provide duct cleanouts to allow for the complete cleaning of the exhaust ductwork system.

- C. Sleeve acoustical duct penetrations through full walls perpendicular to wall surface. Provide 1/2" minimum gap between sleeve and duct. Fill gap with mineral wool backer and seal each side of penetration with acoustical sealant.
- D. Where ducts penetrate through walls into occupied spaces, provide sheet metal escutcheons at each penetration to provide a clean, finished appearance.
- E. Seal duct penetrations of fire resistive construction by methods equivalent to those specified for piping in Section 20 05 29 – Hangers and Supports.

### **3.2 CONSTRUCTION**

- A. Coordinate the routing of ducts with other trades to avoid interference with other building features.
- B. Make penetrations through exterior building walls watertight. Detail ductwork connections to prevent condensation or leakage from entering into surrounding building construction. Provide sleeves, special connections and sealant as required to accomplish this performance requirement.

### **3.3 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.4 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Provide support for ventilation system air balancing in accordance with Section 23 05 93 – Testing, Adjusting and Balancing.

### **3.5 ADJUSTING**

- A. Adjust exhaust system to provide the ventilation flow rates as indicated.

### **3.6 CLEANING**

- A. Prior to final completion, clean equipment and components.
- B. Touchup paint as required.

**END OF SECTION 23 35 00**

**SECTION 23 36 00**  
**AIR TERMINAL UNITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Single Duct Variable Air Volume Terminal Units.
- B. Products Installed But Not Supplied Under This Section:
  - 1. Damper control actuators and application specific controllers. Factory installed by the air terminal unit manufacturer. See Section 25 50 00 – Building Automation and Control.
- C. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00- Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 20 07 00 - Mechanical Insulation
  - 7. 23 05 93 - Testing, Adjusting and Balancing
  - 8. 23 21 13 - Hydronic Piping and Specialties
  - 9. 23 31 00 - Ducts and Accessories
  - 10. 23 40 01 - Duct Cleaning
  - 11. 25 09 00 - Sequences of Operation
  - 12. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. SMACNA – HVAC Duct Construction Standards, Metal and Flexible. Third Edition 2005.
- B. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.
- C. ARI-880-98 – Air Terminals

**1.3 SYSTEM DESCRIPTION**

- A. Performance Requirements: Provide single duct, variable air volume, terminal units with the performance capacities as scheduled.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
- C. Shop drawings:
  - 1. Include scaled Air Terminal Units on ventilation system shop drawings to include the following:
    - a. Equipment tag.
    - b. Control enclosure orientation.
    - c. Ductwork connections and sizes.
    - d. Reheat coil and hydronic piping connections and valving as applicable.
    - e. Coil access door locations.

- D. VAV terminal discharge duct mock-up.
  - 1. Fabricate initial VAV terminal with reheat coil and sound lined discharge plenum/access doors/spin-in branch duct connections for site observation by the Engineer of Record to demonstrate fabrication compliance with Article 2.2.
- E. Quality Control/Control Submittals:
  - 1. Manufacturer's Instructions:
    - a. Provide complete manufacturer's written installation, operation and maintenance instructions for each approved product.
    - b. Clearly annotate the instructions to indicate applicable information for the specific equipment model(s) installed.
- F. Installation, Operation and Maintenance (IO&M) Manuals:
  - 1. Provide copies of the approved products complete installation, operation and maintenance information for inclusion within the project IO&M Manual.
  - 2. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
- G. Closeout Submittals:
  - 1. Refer to Section 20 00 00 - Mechanical General Requirements for Closeout procedures.

## 1.5 QUALITY CONTROL

- A. Manufacturer Qualifications:
  - 1. Company specializing in manufacturing the products specified with five years (minimum) documented experience.
- B. Certifications:
  - 1. Air terminal units certified under ARI Standard 880-98 Certification Program and carry the ARI 880 seal.
- C. Pre-Installation Meetings:
  - 1. Coordinate installation of Air Terminal Units with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any Air Terminal Units.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  - 1. Verify that products are delivered to the site, free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. See to Section 20 00 00- General Mechanical Requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Titus, Model: DESV.
- B. Enviro-Tec.
- C. Nailor Industries.

## 2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL UNITS

- A. Performance:
  - 1. Provide single duct, variable air volume terminal units of the sizes and performance capacities as scheduled.
- B. Casing:
  - 1. Galvanized steel, 22 gauge (minimum) casing construction with NEMA 1, side mounted, control enclosure.
  - 2. Maximum casing leakage not to exceed seven (7) CFM at a differential pressure of 1.0 inch water column static pressure.
  - 3. Round, beaded inlet, low leakage construction neck sized to fit standard round duct.
  - 4. Slip and drive casing outlet for connection to low pressure ductwork or reheat coil.
  - 5. Multi-port, center averaging flow sensor with sensor tubing with flow measurement taps for connection to application specific controller.
  - 6. Casings may be oversized from standard dimensions for specific neck diameters at the factory to match required reheat coil dimensions. This eliminates the need for a transition piece between the casing and reheat coil. Access doors are required upstream and downstream of reheat coils for coil cleaning.
- C. Casing Sound Liner:
  - 1. UL Listed and in conformance with NFPA Standard 90A.
  - 2. Non-porous insulation (1-1/2 pound per square foot minimum density) with scrim reinforced foil facing.
  - 3. Cut liner edges sealed to prevent erosion with discharge edges secured with metal brackets.
- D. Control Damper:
  - 1. Heavy gauge steel construction, butterfly type damper.
  - 2. One-piece, 1/2-inch diameter damper shaft with self-lubricating Delrin® or bronze oilite bearings.
  - 3. Elastomer damper seal to limit close-off leakage to a maximum of 5 CFM at 1.5 inches water column static pressure.
  - 4. Notched shaft end, which indicates damper position.
  - 5. Mechanical stop to prevent damper over-stroking.
- E. Control Actuator and Application Specific Controller:
  - 1. Furnished directly to the air terminal unit manufacturer for factory installation by Section 25 50 00 – Building Automation and Control.
- F. Hydronic Reheat Coils:
  - 1. Provide hydronic reheat coils with the scheduled performance characteristics.
  - 2. Provide coils constructed from seamless copper tubing (minimum 0.016" wall thickness) with aluminum fins and 20 gauge (minimum) galvanized steel casings with slip and drive connections. Provide extended coil sweat copper supply and return connections.
- G. Duct Transitions:
  - 1. Provide field fabricated duct transitions between terminal unit outlet and reheat coil inlet.
  - 2. Provide rectangular reheat coil discharge plenum.
    - a. Minimum width to match reheat coil width.
    - b. Minimum height to match reheat coil height or maximum downstream branch duct spin-in connection diameter plus four (4) inches, whichever is greater.
  - 3. Sound line duct transitions and plenums to match terminal unit casing liner.
  - 4. Contractor's Option: Provide oversized terminal unit casing to match reheat coil dimensions with neck/damper size as scheduled to eliminate the requirement for field fabricated duct transitions between terminal unit outlets and reheat coil inlets.
- H. Sound Rating:
  - 1. Sound data certified by ARI.

2. Sound ratings for basic Air Terminal Units with inlet diameters less than or equal to sixteen (16) inches not to exceed NC-22 at maximum rated flow (CFM) with a differential static pressure drop of 1.0 inch water column.
3. Sound ratings for basic Air Terminal Units with inlet diameters larger than sixteen (16) inches not to exceed NC-35 at maximum rated flow (CFM) with a differential static pressure drop of 1.0 inch water column.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection: Cover air terminal unit inlet and discharge openings to protect components from construction dirt and debris.

#### **3.2 INSTALLATION**

- A. Install Air Terminal Units in strict compliance with the manufacturer's written installation instructions.
- B. Locate complete terminal unit assembly, including reheat coil and associated low pressure sound lined plenums at the locations indicated. Do not locate any part of this assembly such that it passes over a partition wall or through a full height wall penetration.
- C. Locate terminal units such that the bottom of the complete assembly is six (6) inches above the top of the ceiling grid or hard lid ceiling framing as applicable.
- D. Support Air Terminal Units independent of duct system. Provide sway bracing within 12 inches of support attachment.
- E. Locate control panel on side of unit that maximizes accessibility (i.e. away from full height walls and main duct runs).
- F. Connect air terminal unit inlets to ductwork using straight sections of unrestricted rigid duct of the same inlet diameter as terminal unit inlet. Provide a minimum straight duct length of 4 duct diameters at each terminal unit inlet. Medium pressure flexible duct connections to terminal units is not allowed except where specifically shown.
- G. Close-coupling of a terminal inlet to the side of a main supply duct is not acceptable without written permission for the Department's Representative. When this method is approved, provide an inlet flow straightening device. Adjust the air terminal unit velocity sensor bias adjustment to provide accurate flow measurement.
- H. Install low pressure ductwork branches vertically centered along the sides of the low pressure sounded lined plenums. A minimum of two(2) inches of sheet metal is required between the spin-in (or similar connection) and top and bottom external edge of the metal plenum.
- I. Provide insulated access doors upstream and downstream of reheat coil for coil cleaning.

#### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  1. Coordinate the installation of Air Terminal Units with trades responsible for portions of this and other related sections of the Project Manual.
  2. Coordinate ceiling and/or wall access panel locations to provide convenient maintenance and cleaning access for each air terminal unit.
  3. Coordinate air terminal unit locations with ceiling grids, lighting troffers, air outlets and return grilles to maximize accessibility and minimize interference.
  4. Rework required as a result of failure to follow the manufacturer's written installation instructions, properly coordinate the installation with related work, or provide adequate access (as determined by the Department's Representative) shall be completed at no additional cost to the Department.

**3.4 REPAIR/RESTORATION**

- A. Repair or replace new any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

**3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

**3.6 ADJUSTING**

- A. Adjust and balance zone air flow volume in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.
- B. Cycle air terminal control damper between minimum and maximum scheduled air flow settings utilizing the BAS to verify proper operation and capacity.
- C. Adjust velocity sensor bias adjustment as necessary to provide accurate air flow measurement.
- D. Verify reheat coil and auxiliary heat (as applicable) hydronic control valves properly cycle with control damper in accordance with Section 25 09 00 – Sequence of Operation.
- E. For units with reheat coil supply temperature sensors, verify maximum supply temperature is limited to twenty (20) degrees F above zone temperature setpoint.
- F. Verify mechanical connections, electrical and control wiring and sensor tubing are properly secured.
- G. Secure control enclosure cover in place as intended by the manufacturer.

**3.7 CLEANING**

- A. Upon completion of installation and prior to initial operation, vacuum clean and wipe down Air Terminal Units and control enclosures.
- B. Remove any debris from control enclosure.
- C. Inspect and clean reheat coils. Re-straighten coil blades if necessary.

**3.8 DEMONSTRATIONS AND TRAINING**

- A. With the applicable central ventilating system air balancing completed and the ventilating system operating under automatic control utilizing the BAS, cycle each air terminal unit and associated control valve(s) to demonstrate proper operation in accordance with 25 09 00 – Sequence of Operation for verification by the Department's Representative.

**END OF SECTION 23 36 00**

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**SECTION 23 36 16**  
**LABORATORY VENTILATION SYSTEMS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. General, fume hood, snorkel and storage cabinet exhaust air valves.
  - 2. Specialized, automatic, direct digital control system, compatible with the building automation system (BAS), for control and monitoring of laboratory temperature and pressurization.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00- Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 31 00 - Ducts and Accessories
  - 8. 23 36 00 - Air Terminal Units
  - 9. 23 37 00 - Air Outlets and Inlets
  - 10. 23 40 01 - Duct Cleaning
  - 11. 23 70 00 - Central Air Handling Units
  - 12. 25 09 00 - Sequences of Operation
  - 13. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. International Mechanical Code (IMC).
- C. ASHRAE Handbook 2011 - HVAC Applications, Chapter 16 – Laboratories.
- D. ASHRAE Standard 110 – Method of Testing Performance of Laboratory Fume Hoods.

**1.3 SYSTEM DESCRIPTION**

- A. Specialized, automatic, direct digital control system, compatible with the building automation system (BAS), for control and monitoring of:
  - 1. Fume hood operation.
  - 2. Snorkel operation
  - 3. Laboratory temperature control.
  - 4. Laboratory humidity control.
  - 5. Laboratory positive/neutral/negative pressurization using the airflow tracking method.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00– Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria of products specified.
- C. Shop Drawings:
  - 1. Provide scaled shop drawings which incorporates the following installation information:
    - a. Fume hood and snorkel locations and arrangements.
    - b. Supply and exhaust duct routing.

- c. Control device and panel locations.
- d. Control and wiring diagrams.
- D. Installation, Operation and Maintenance (IO&M) Manuals:
  - 1. Provide a complete manufacturer's written installation, operation and maintenance manual for each piece of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
- E. Quality Control/Control Submittals:
  - 1. Pre-functional Installation (PC) and Functional Performance Test (FC) Checklists in accordance with Section 01 91 00 – Commissioning.
- F. Closeout Submittals:
  - 1. Project record drawings: Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation of the Central Air Handling Units.

### 1.5 QUALITY CONTROL

- A. Pre-Installation Meetings: Coordinate installation of the laboratory equipment which is to be connected to the central exhaust system (biological safety cabinets, fume hoods and snorkels) with trades responsible for portions of this and any other related sections of the Project Manual prior to installation.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  - 1. Verify that products are delivered to the site, free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

### 1.7 WARRANTY

- A. Refer to Section 20 00 00- General Mechanical Requirements.

## PART 2 - PRODUCTS

### 2.1 LABORATORY ROOM CONTROLLER (LPC)

- A. Microprocessor-based, multi-tasking, real-time digital control processor specifically designed for the control of laboratory temperature, humidity, differential pressure monitoring and room ventilation. Full stand-alone operation capability. LPC to include inputs and outputs necessary to perform the specified control sequences.
- B. Include control sequences as part of the factory-supplied software. Field customize control sequences by adjusting parameters such as control algorithm gains, temperature setpoint, alarm limits, airflow differential setpoint, and pressurization mode. Utilize closed loop proportional integral derivative (PID) control algorithms to maintain temperature and airflow offset setpoints.
- C. Control exhaust air valve to maintain an actual CFM differential between total exhaust and supply air equal to 10% of the laboratory design airflow or 100 CFM (adjustable), whichever is greater, to meet space pressurization requirements. Supply air volume shall track exhaust airflow and lag by the required air volume differential to maintain "negative" room pressures. Supply air volume shall track exhaust airflow and lead by the required air volume differential to

maintain "positive" room pressures. Track air valve flow rate utilizing airflow stations integral with the exhaust air control valves.

- D. Electronic controllers are acceptable provided they are used in conjunction with a linear airflow control device with equal percentage flow characteristics.
- E. Controller shall use differential pressure transducers to measure air flow (or air valves that use a differential pressure switch to monitor differential pressure across the valves) shall include provisions for manual and automatic calibration in order to maintain stable control and prevent drift over time. Controllers shall automatically calibrate the transducer without changing the damper position.
- F. Provide databases and programs stored in non-volatile EEPROM, EPROM and PROM, or provide 72-hour battery backup (minimum).
- G. Provide LPC capable of returning to full normal operation without user intervention after a power failure of unlimited duration.
- H. In the event of LPC failure, the exhaust air valve damper automatically modulates to the fully open position.

## **2.2 VARIABLE AIR VOLUME SUPPLY AIR TERMINAL UNITS**

- A. See Section 23 36 00 - Air Terminal Units

## **2.3 LABORATORY EXHAUST AIR FLOW CONTROL VALVES**

- A. Electronically actuated, pressure independent airflow control valves.
- B. Construction:
  - 1. Fume hood and Point of Use Snorkels (with tasks lights): Type 316 stainless steel with solid stainless steel damper shaft with Teflon bearings.
  - 2. General laboratory exhaust and snorkels used for equipment heat removal (without tasks lights): Galvanized steel construction.
- C. Accuracy and performance:
  - 1. Flow accuracy: AMCA certified, plus/minus five (5) percent flow accuracy over entire flow range of valve.
  - 2. Air flow turn down ratio: Five (5) to one (1) minimum turn down.
  - 3. Control response time: Fast acting or slow acting as scheduled.
  - 4. Maximum pressure drop: 0.6 inches at maximum rated airflow.
  - 5. Accuracy and performance guaranteed regardless of field conditions.
- D. Exhaust airflow measurement shall be provided by techniques that minimally obstruct the exhaust duct. Pitot tube arrays are NOT acceptable for exhaust airflow measurement.
- E. Calibration: Each air valve marked with specific factory calibration data to include:
  - 1. Tag number.
  - 2. Serial number.
  - 3. Model number.
  - 4. Eight point characterization information.
  - 5. Quality control inspection numbers.
- F. Air flow monitoring:
  - 1. Provide monitoring of airflow through air valve. Transmit signal to room controller on loss, increase and/or decrease of airflow.

## **2.4 FUME HOODS**

- A. See Division 11.

## 2.5 FUME HOOD CONTROL SYSTEM

- A. General: Back fit fume hood with control system components provided by the BAS sub-contractor
- B. Fume Hood Controller:
  - 1. Provide a dedicated, UL listed fume hood controller, which continuously maintains a constant sash face velocity setpoint (adjustable). The controller maintains a constant average face velocity as the fume hood sash is raised and lowered. The controller calculates average face velocity from exhaust cfm and hood open area. This face velocity is compared to the setpoint to calculate the required exhaust flow. The controller then positions the airflow control device to maintain the required exhaust airflow. The controller performs this calculation eight times per second to ensure maximum speed of response to changes in sash position.
  - 2. Sash sensing provides a "feed forward" input to the controller that allows corrective action to begin immediately upon sash movement and be completed when movement stops.
  - 3. Provide "Sash Alert" feature with audible alarm (adjustable and/or programmed off) at the Operator Display Panel when the sash is left open above safety recommended working height (adjustable) for an adjustable period of time.
  - 4. Provide a general alarm output to the BAS.
  - 5. Momentary or extended losses of power shall not change or affect any of the control system's setpoints, calibration settings, or emergency exhaust mode status. On return of power, controller returns to normal operation.
- C. Fume Hood Operator Display:
  - 1. Provide operator display for fume hood to comply with laboratory safety standards, complete with the following:
    - a. Indicator lights that verify normal operation (green), marginal operation (yellow), and alarm condition (red). Initiate an alarm for both high and low face velocity conditions.
    - b. Initiate an audible alarm in response to an alarm condition. Include a silence button, which silences the audible alarm.
    - c. Provide an emergency purge button that initiates the visual and audible alarm and sequences the fume hood exhaust to maximum airflow. When the emergency purge button is depressed a second time, the emergency sequence is terminated and the fume hood controller returns to normal operation.
- D. Sash Sensor:
  - 1. Provide sash position sensor to measure the actual fume hood sash position. The sash sensor shall be a precision, linear device with repeatable location accuracy within one inch.
  - 2. Corrosion resistant sensor material capable of withstand Salt Fog (Marine) type tests.
  - 3. Sensor located to allow for complete and easy removal of the sash for cleaning and maintenance.
  - 4. Operational sensor life: 250,000 cycles (minimum).
  - 5. Provide sash sensor failure audible alarm at fume hood operator display panel.

## 2.6 SNORKEL VENTILATION CONTROL SYSTEM

- A. Compatible for direct connection to BAS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install products in accordance with the specific manufacturer's written installation, operation and maintenance manuals (IO&M).
- B. Provide fume hood sash sensor, interface boxes, and monitors for fume hood. Install and terminate low voltage control wiring and 24 VAC power supplies.

- C. Provide 120-volt power connection in the laboratory space (by electrical subcontractor).

### **3.2 ADJUSTING FUME HOODS**

- A. Test, adjust and balance the fume hoods in accordance with the fume hood manufacturer's written installation and operating instructions, factory supplied test data and ASHRAE Standard 110.
- B. Calibrate associated fume hood exhaust air valve to maintain appropriate sash velocity over full range of sash positions.
- C. Coordinate with Section 23 05 93 – Testing, Adjusting and Balancing.

### **3.3 ADJUSTING LABORATORY DIFFERENTIAL PRESSURES**

- A. Utilizing the Pressure Maps, program each independent room controller to automatically maintain the indicated pressure differential with respect to adjacent spaces regardless of fume hood or snorkel operation.

### **3.4 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.5 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down internal and external surfaces.

### **3.6 SYSTEM STARTUP**

- A. Start-up and operate laboratory ventilation equipment in accordance with the manufacturer's written installation, operation and maintenance manuals.
- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

### **3.7 ADJUSTING**

- A. Test, adjust and balance laboratory ventilation equipment in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

### **3.8 DEMONSTRATIONS AND TRAINING**

- A. Provide Demonstrations and Training in accordance with Division 1.
- B. Provide specialized instruction to designated personnel in the adjustment, operation and maintenance of the laboratory ventilation system.
- C. Provide 8 hours of training for Department's Representative operating personnel to include:
  1. Explanation of drawings, operations and maintenance manuals.
  2. Physical walk-through to locate control components.
  3. Laboratory controller's operation/function.
  4. Explanation of adjustment, calibration and replacement procedures.

**END OF SECTION 23 36 16**

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**SECTION 23 37 00**  
**AIR OUTLETS AND INLETS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Air Diffusers.
  - 2. Return/Exhaust Grilles.
  - 3. Stationary Louvers.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 08 44 00 - Curtain Walls, Storefronts, and Entrances
  - 3. 20 00 00- Mechanical General Requirements
  - 4. 23 05 93 - Testing, Adjusting and Balancing
  - 5. 23 31 00 - Ducts and Accessories
  - 6. 23 40 01 - Duct Cleaning

**1.2 REFERENCES**

- A. SMACNA HVAC Duct Construction Standards – Metal and Flexible Third Edition 2005.
- B. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

**1.3 SUBMITTALS**

- A. Refer to Section 20 00 00– Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
  - 2. Submit color selections for diffusers and grilles from manufacturer's color selection chart.
- C. Shop Drawings:
  - 1. Include scaled ventilation system shop drawings which incorporate the following installation information from this section:
    - a. Air diffuser and grille locations, duct connection sizes and throw directions.
    - b. Louver locations with connecting duct/plenum dimensions.
    - c. Louver penetration details which clearly show wall type, louver frame type, duct connection method, sealant and or gasket locations and drainage path.
    - d. Louver blank-off panel dimensions, to be coordinated with louver manufacturer.
- D. Quality Control/Control Submittals:
  - 1. Manufacturer's Instructions:
    - a. Provide complete manufacturer's written installation instructions for each product.
    - b. Clearly annotate the instructions to indicate applicable information for the specific equipment model(s) installed.
- E. Installation, Operation and Maintenance (IO&M) Manuals:
  - 1. Refer to Section 20 00 00– Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
  - 2. Provide copies of approved submittal information for inclusion within the project IO&M Manual.

#### **1.4 QUALITY CONTROL**

- A. Pre-Installation Meetings: Coordinate installation of air diffusers, grilles and louvers with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any products.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Acceptance at Site:
  - 1. Verify that products are delivered to the site, free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.

#### **1.6 WARRANTY**

- A. See to Section 20 00 00 - Mechanical General Requirements for general mechanical warranty requirements.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers for air diffusers and return/exhaust grilles:
  - 1. Titus (Basis of Design).
  - 2. Price.
  - 3. Anemostat.
  - 4. Nailor Industries Inc.
  - 5. Kreuger.

#### **2.2 AIR DIFFUSERS**

- A. Provide air diffusers with the performance characteristics as scheduled.
- B. Finish: Standard white, baked enamel finish suitable for field application of custom finish color as required.
- C. Provide round, square or rectangular diffusers complete with equalizing grids.
- D. Provide diffusers with modules of the proper size to match the suspended ceiling layout or with factory provided frames for surface mounting.
- E. Fully correlate diffuser and grille style, dimension, and fit with ceiling type.

#### **2.3 RETURN/EXHAUST GRILLES**

- A. Provide return/exhaust grilles with the performance characteristics as scheduled.
- B. Finish: Standard white, baked enamel finish suitable for field application of custom finish color as required.
- C. Provide grilles with modules of the proper size to match the suspended ceiling layout or with factory provided frames for surface mounting.
- D. Fully correlate grille style, dimension, and fit with ceiling type.

## **2.4 WALL LOUVERS**

- A. Refer to section 08 44 00 Curtain Walls, Storefronts, and Entrances.
- B. Performance: Provide wall louvers sized as scheduled and with performance ratings equal to or better than scheduled free area velocity and air pressure drop. Manufacturer's ratings based on testing in accordance with AMCA Publication 511. Louvers shall bear the AMCA Certified Ratings Seal for water and air.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protection: Store products in original factory packaging until actual installation.

### **3.2 INSTALLATION**

- A. General:
  - 1. Install products in compliance with the manufacturer's written installation instructions.
  - 2. Connect air outlets, grilles and louvers to ventilation duct systems in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
- B. Air Diffusers and Grilles:
  - 1. Install air diffusers and return/exhaust grilles at the locations shown.
  - 2. Orientate and adjust diffusers to provide the throw directions indicated.
  - 3. Provide appropriate borders for the ceiling, wall or floor construction type indicated.
- C. Wall Louvers:
  - 1. Install wall louvers at the locations shown in accordance with manufacturer's written installation instructions and installation details for the wall type shown.
  - 2. Seal louver penetrations in accordance with section 08 44 00 Curtain Walls, Storefronts, and Entrances. Install, seal and insulate louver ductwork (intake or exhaust/relief plenums) to interior louver frame to prevent condensation or entrained water that enters ductwork from leaking into building. Provide sleeves, special connections and sealant as required to accomplish this performance requirement.
  - 3. Slope plenum ductwork such that any entrained water drains out through base frame of wall louver.

### **3.3 REPAIR/RESTORATION**

- A. Repair or replace with new any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.4 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Site Tests:
  - 1. Louvers: Prior to insulating louver intake and exhaust/relief plenums, with applicable fans shutdown, lightly spray water into louver from building exterior such that water enters plenums. Verify that the water readily drains out of louver base frame without pooling and that no visible leakage is present. Repair and retest as necessary until performance requirements are met.

### **3.5 ADJUSTING**

- A. Adjust and balance zone air flow volume and throw pattern in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

**3.6 CLEANING**

- A. After construction is completed, clean and wipe down exposed inlet and outlet surfaces.
- B. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

**END OF SECTION 23 37 00**

**SECTION 23 40 01  
DUCT CLEANING**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Ductwork and ventilation system equipment cleaning.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00- Mechanical General Requirements
  - 3. 23 31 00 - Ducts and Accessories
  - 4. 23 34 00 - Fans
  - 5. 23 36 00 - Air Terminal Units
  - 6. 23 37 00 - Air Outlets and Inlets
  - 7. 23 70 00 - Central Air Handling Units
  - 8. 23 82 00 - Terminal Heating and Cooling Units

**1.2 REFERENCES**

- A. National Air Duct Cleaners Association (NADCA) Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components, 1992-01.
- B. NFPA 90A – Installation of Air-Conditioning and Ventilating Systems.
- C. ASTM D 93 – Flash-Point by Pensky-Martens Closed Cup Tester.
- D. ASTM E 96 – Water Vapor Transmission of Materials.

**1.3 DESCRIPTION**

- A. This section describes specific requirements and methods for cleaning ductwork and ventilating system equipment.
- B. Implement this section in the event that the new ventilation systems become contaminated with construction debris as described in Section 23 31 00 - Ducts and Accessories prior to project Final Completion.

**1.4 SCOPE**

- A. Clean and inspect supply air diffusers, return air slots and grilles.
- B. Remove and replace excessively dirty flexible duct run outs to air outlet diffusers and return air grilles with new flexible ductwork.
- C. Clean terminal air units to include Fans and reheat coils.
- D. Clean supply ductwork from fan discharge connection points to each air discharge point.
- E. Clean central air handling unit components.
- F. Clean outside air louvers, plenums and dampers.
- G. Clean fan room interior surfaces and fan room mounted equipment.
- H. Clean return plenum horizontal surfaces (above ceiling tiles/hard lids).

**1.5 QUALITY CONTROL**

- A. Duct cleaning work shall be performed by a firm with three (3) years continuous, documented experience with similar work.
- B. Submit references for a minimum of five (5) recently successfully Duct Cleaning projects.

## 1.6 QUALITY CONTROL

- A. The Department's Representative's Maintenance Department shall be able to inspect each stages of the work and shall be able to utilize the Contractor's fiber-optic bore scope with dedicated light source, as necessary, to spot-check treated areas.
- B. The Department's Representative's Maintenance Department shall have its own reporting procedures site verify the Contractor 's report.

## 1.7 SUBMITTALS

- A. Duct Access Point/Door Locations:
  - 1. Select and document new access point/door locations and sizes on a clean set of Contract Drawings during cleaning preparation using the access door symbol provided in the Legend. Submit for written approval by the Department's Representative prior to installing duct access points/doors.
- B. Preliminary Report: Provide a written preliminary report, prior to any cleaning or duct repair work which:
  - 1. Defines the physical limits/boundaries of the central air distribution system ductwork and equipment to be cleaned.
  - 2. Provides a general assessment of the condition of the ductwork and equipment to be cleaned.
  - 3. Include a "before" digital photograph for each section of ductwork and equipment to be cleaned which clearly documents the existing condition of the ductwork. Include a key map (floor plan(s)) which clearly show the location and direction of each photograph taken.
  - 4. Provide formal written recommendations regarding the most appropriate cleaning method(s) for each portion of the duct system and equipment to be cleaned. Use cleaning methods selected from the National Air Duct Cleaners Association (NADCA) Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components.
  - 5. Includes a written copy of the specific recommended cleaning procedures to be implemented.
- C. Final Condition Report: Provide a written final condition report within fifteen (15) days of completely duct and equipment cleaning which:
  - 1. Demonstrates that there is no visible dirt or contamination at any point within the systems which were cleaned.
  - 2. Include an "after" digital photograph next to each "before" digital photograph for each section of ductwork and each piece of equipment which clearly documents the cleaning process. Take the "after" photograph from the same orientation as the previously submitted "before" photograph.

## PART 2 - PRODUCTS

### 2.1 CLEANING EQUIPMENT AND CLEANING PERSONNEL

- A. Provide equipment and materials for cleaning including scaffolding, wire brushes, rotary brushes, filters, air lances, mechanical agitators, fiber-optic borescopes, vacuums, and other equipment and materials necessary for workmen to perform the specified work.
- B. Cleaning personnel shall be properly supervised by a qualified, experienced foreman. Foreman shall be prepared to discuss work in progress, at anytime with the Department's Representative.
- C. Provide HEPA systems which are self-contained units with appropriate components and appurtenances, to adequately prevent dirt and debris loosed from duct mains and branches during cleaning operations from entering sensitive locations. Utilize industrial grade HEPA filter elements labeled and certified for 99.9% efficiently (0.3 micron particles at rated air flow). Wherever practicable, do not discharge air from HEPA systems to clean spaces. Size

volumetric capacity of HEPA filter system to match CFM rating of diffuser, mixing box, ductwork section or device to which unit is being connected.

## **2.2 ACCESS DOORS**

- A. When sections of ductwork and/or plenum areas are found to be inaccessible for proper inspection and cleaning, provide new galvanized steel access doors as required for proper access in accordance with 23 31 00 - Ducts and Accessories.

## **2.3 FLEXIBLE DUCT**

- A. Replace dirty flexible ductwork in accordance with Section 23 31 00 – Ducts and Accessories.

## **PART 3 - EXECUTION**

### **3.1 CLEANING PREPARATION**

- A. Study the Contract Documents provided by the Department's Representative to become familiar with the general layout of existing systems to be cleaned.
- B. Conduct site visit(s) to verify the scope of work, accessibility to ductwork and equipment and existing conditions.
- C. Select and document new access point locations and sizes on a clean set of Contract Drawings and submit for approval.
- D. Obtain written Notice to Proceed from the Department's Representative prior to beginning duct and equipment cleaning procedures.

### **3.2 INSTALL ACCESS POINTS**

- A. Install access points/doors at approved locations throughout supply, return and exhaust air ductwork. Install access points/doors as follows:
  - 1. Install access points/doors at not greater than twenty (20) foot intervals to allow the thorough cleaning and inspection of each segment of ductwork.
  - 2. Do not cut into existing ductwork other than to install new access doors.
  - 3. Neatly record location of each access door on project record drawings. Use access door symbol as indicated in Legend.
  - 4. When access doors are installed in insulated ductwork, provide access doors which meet the "R" rating of the duct insulation.

### **3.3 PRE-CLEANING INSPECTION**

- A. Perform a full inspection of the duct interior through the installed access points/doors as follows:
  - 1. Utilizing a fiber-optic boroscope with dedicated light source to inspect interior ductwork surfaces and ductwork accessories including terminal units, mixing boxes, ductwork liners, duct-mounted coils, filters, dampers, humidifiers, and other appurtenances within ductwork systems.
  - 2. Visually inspect air handlers and air handler components. Visual inspection shall include, but not be limited to all filters, coils, holding frames, Fans, flooring, ceilings, wall paneling, air plenums, dampers, and outside air intakes.
- B. Prepare and submit Preliminary Report as outlined in Submittals. Promptly notify The Department's Representative in writing of any existing conditions/major damage that may prevent the complete cleaning of the air distribution systems as shown.

### **3.4 INSTALL TEMPORARY FILTERS**

- A. Prior to cleaning, provide temporary 30 percent filters fitted and sealed at supply grilles and diffusers.

- B. Protect openings to avoid particulate contamination and debris from falling into conditioned air spaces.

### 3.5 DUCT CLEANING

- A. Control access for cleaning personnel and equipment through installed access points, existing ceiling tiles, access doors, diffusers or grilles. Replace items removed for access to their original state upon completion of work.
- B. By inserting special air lances, mechanical agitators and rotary brushes through the installed access points, gently loosen and remove construction debris from the interior surfaces of the ductwork. Utilize temporary filters and blanking pieces to protect areas that are not currently being treated.
- C. Utilize specialized fan-powered, HEPA filtered dust and particulate collection systems in areas designated as being sensitive and as directed by the Department's Representative. Take precautions to prevent dirt and debris greater or equal to 0.5 microns from entering these sensitive areas.
- D. Thoroughly hand wash duct mounted coils (using air or water) on both coil faces carefully to avoid damage to tubes and fins. Hand brush and vacuum clean coil frames to remove corrosion from around coil frames. Comb coil fins to restore alignment.
- E. Mark duct mounted dampers at their current setting. Then inspect and clean dampers by manually hand scraping, sanding or wire brushing. Lubricate external moving parts with an approved dry lubricant material (Aerolox Dry Moly or equal). After cleaning return and lock dampers at original setting positions.
- F. Repair/replace existing damaged duct insulation. If existing insulation is exposed without neoprene, foil or approved facing, coat surface with sealer. See Section 20 07 00 - Mechanical Insulation for sealer requirements.
- G. Whenever supply/diffusers and return/exhaust grilles are removable, mark existing damper settings (as applicable) and remove them prior to cleaning. Vacuum clean, wash, dry and reinstall diffusers and grilles. Clean welded grilles in place. Return dampers to original setting positions after reinstallation.

### 3.6 AIR HANDLING UNITS

- A. Shutdown/restart central air handling systems based upon a pre-arranged schedule approved in advance by the Department's Representative. Once cleaning is complete, restore central air handling equipment to their normal operating mode.
- B. Clean and repair central air handling units located in mechanical rooms or equipment areas as follows:
  - 1. Remove existing filter bank elements.
  - 2. Hand wire brush interior sides, ceiling and floor areas to loosen surface contaminants and vacuum clean.
  - 3. Utilizing a high pressure water cleaning system with a suitable cleaning agent to thoroughly clean heating/cooling coil faces.
  - 4. Vacuum clean and hand wash control dampers. Replace damaged rubber seals.
  - 5. Vacuum clean and hand wash fan casing and Motors to remove debris.
  - 6. Hand scrape/wire brush, vacuum clean, fan impellers and casings.
  - 7. Repair/replace existing damaged duct insulation. If existing insulation is exposed without neoprene, foil or approved facing, coat surface with sealer. See Section 20 07 00 - Mechanical Insulation for sealer requirements.
  - 8. Replace filter bank elements with elements provided by the Department's Representative.
  - 9. Hand wash and rinse exterior air handler surfaces.

- C. Prior to reactivating of air handler system:
  - 1. Verify that all painted surfaces are properly dried.
  - 2. Verify that all air handler surfaces are thoroughly cleaned and dried.
  - 3. Filter elements are installed.
  - 4. Fan belt guards are installed.
  - 5. Notify the Department's Representative prior to restart of air handler and coordinate system restart with facility operation.

### **3.7 SYSTEM RESTORATION**

- A. Upon completion of the ductwork and equipment cleaning, carefully remove filters from the ceiling diffusers to avoid spilling loose contamination onto room surfaces. Dispose of filters in sealed containers.
- B. Upon completion of work, and at the end of each shift, clean work area of trash, rubble, rags, containers, materials and equipment resulting from the work and remove from site. Broom clean the Department's Representative's designated work/storage areas.
- C. When cleaning procedures are completed, return electrical switches, detection devices and system components to an operable state by qualified personnel.
- D. Plug access ports with plugs specifically designed for the intended purpose.
- E. Shut and latch access doors. Adjust as necessary for a tight air seal.

### **3.8 SITE INSPECTION AND FINAL CONDITIONS REPORT**

- A. Provide the Department's Representative with 48 hours advanced notice prior to site inspection.
- B. Visually inspect all cleaned duct interior surfaces, ductwork accessories and air handlers as identified in the project's scope of work.
- C. Inspect ductwork interior surfaces and non-accessible ductwork components within the air stream via the installed access points/doors, utilizing the fiber optic borescope with dedicated light source.
- D. Photo document post cleaning conditions and submit with Final Conditions Report. See Submittals for specific report requirements.

**END OF SECTION 23 40 01**

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**SECTION 23 52 13**  
**ELECTRIC HYDRONIC BOILERS AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Packaged electric hot water boilers and appurtenances.
  - 2. Packaged boiler control system.
- B. Related sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 14 - HVAC Pumps
  - 9. 25 09 00 - Sequences of Operation
  - 10. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. ASME Boilers and Pressure Vessel Code (1998), Sections IV & VI.
- C. ASME CSD-1, latest edition.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements: This section describes specific requirements, products and methods of execution for systems necessary for the generation of hydronic heat utilizing centralized electric boilers.
- B. Performance Requirements: Provide electric boiler (BLR-1) with the physical and performance characteristics as scheduled and specified and orientated as shown within the drawings.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00– Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria.
  - 2. Include the following:
    - a. Indicate which model is being submitted.
    - b. Boiler physical and performance characteristics as scheduled. Boiler physical and performance characteristics as scheduled. Include weight of equipment filled with water. Boilers weighing more than 20 percent heavier than the schedule equipment, or if located differently than shown, will be disapproved unless it is determined by the Department's Representative that structure is able to bear the additional weight. Contractor may elect to increase structural support, in which case proposed changes to the structure and calculations stamped by a registered engineer shall be submitted.
    - c. Dimensional data.

- d. Features and appurtenances being provided.
- C. Shop Drawings:
  1. Submit fully dimensioned shop drawings of boiler room showing major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown.
  2. Submitted boiler shall be dimensionally equal to scheduled product within six inches in each dimension. Maintain clearances shown on drawings. Submit fully dimensioned shop drawings of boiler room(s) at drawing scale of 1/4-inch equals one foot zero inches or larger, showing entire boiler room, equipment and deviations. Provide boiler room modifications required due to dimensional and technical deviation at no additional cost to the Department. Submit shop drawings of proposed equipment layout and base or pad for each piece of equipment.
  3. If equipment to be provided exceeds the weight of the specified equipment by more than 20 percent, or if the location is to be altered, submit shop drawings and calculations of proposed revised structural design, noting location of pertinent loads, stamped by a registered professional engineer.
  4. Indicate mechanical and electrical service locations and requirements.
- D. Quality Control/Control Submittals:
  1. Start-up and Test Reports: Provide start-up and operational test reports for each boiler.
- E. Closeout Submittals:
  1. Project Record Documents: Record actual locations of equipment, piping, and components and areas required for maintenance access.
  2. Operation and Maintenance (O&M) Manuals:
    - a. Refer to Section 20 00 00– Mechanical General Requirements, for O&M Manual formatting requirements and number of copies required.
    - b. Include copies of approved submittal information within the project O&M Manual.
    - c. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list for each piece of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - d. Include software manuals for equipment furnished under this section.
    - e. Included with the manual one copy of the completed start-up and operational test report. The report shall include printed names and signatures of the installers, and documentation that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
    - f. Boiler and combustion management system startup reports.
    - g. Software Licenses for software installed in equipment furnished under this Section.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  1. Manufacturer qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
  2. Acceptable Installers: Minimum three years experience in the installation and start-up of boilers.
  3. A factory-authorized technician shall perform boiler startup service.
  4. The manufacturer's authorized technician shall supervise the installation, startup, programming, and adjustment of the Energy Management System.
- B. Pre-Installation Meetings: Coordinate installation of boilers and associated piping and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.
- C. Regulatory Requirements: Provide automatic boiler controls listed in the Mechanical Code and ASME CSD-1, latest edition, together with most current addenda and interpretations.

## 1.6 WARRANTY

- A. See to Section 20 00 00 - Mechanical General Requirements for general mechanical warranty requirements.
- B. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.

## PART 2 - PRODUCTS

### 2.1 HOT WATER BOILER - ELECTRIC

- A. Provide a factory pre-assembled electric boiler (BLR-1) with a thermal output not be less than and no more than 10 percent greater than the scheduled thermal input wattage. Provide electrical power voltage and phase as scheduled.
- B. Anchor boiler to its housekeeping pad in Accordance with the seismic requirements of Section 13 48 00 - Vibration and Seismic Control.
- C. Provide the following features:
  - 1. UL labeled.
  - 2. ASME pressure vessel.
  - 3. CSD-1 compliance.
  - 4. Solid state step controllers with quick change out modules, circular run mode (for equal wear), logic system status light, fused output stages, adjustable time delay and cycling (time proportioning of power) adjustment. Minimum of 20 steps.
  - 5. Insulated metal jacket (4").
  - 6. ASME safety relief valve (50 psig).
  - 7. Steel base frame.
  - 8. Low point system drain valve with end cap.
  - 9. Mechanically mounted heating elements. Each rod individually removal and field replaceable with no welding or brazing.
  - 10. Internal power distribution wiring using mechanical lugs, current limiting fuses, and magnetic contactors.
  - 11. Flow switch.
  - 12. Non-fused electrical disconnect.
  - 13. Voltmeter and ampmeter.
  - 14. Outdoor sensor and indoor/outdoor rest.
  - 15. Instrument panel complete with the following:
    - a. ON/OFF switch.
    - b. Manual limit switch.
    - c. Automatic Temperature Controller.
    - d. Status lights for each stage/step of control.
    - e. 120 V Control Transformer.
    - f. Digital temperature readout.
    - g. Boiler supply temperature gauge.
    - h. Boiler return temperature gauge.
  - 16. Building Automation System interface:
    - a. LOCAL/BAS switch.
    - b. Common Trouble alarm contacts.
    - c. Pump flow proof dry contacts.
    - d. Pump start switch.
    - e. Firing rate input (0-10V, 4-20 ma).
  - 17. Main Power Disconnect.
  - 18. Additional components as necessary to provide a complete operational system.
- D. Manufacturers: Cemline (Basis of Design) or pre-approved equal.

## **2.2 LOW WATER CUTOFF**

- A. Provide McDonnell Miller #63M series low water cut-off. Working pressure 50 PSIG. UL/FM approved. Provide McDonnell Miller TC-4 test and check assembly.

## **2.3 AUXILIARY HIGH LIMIT**

- A. Provide Honeywell Model L4006-E auxiliary high limit sensor wired to the building automation system.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Protection: Cover boilers and burners and plug piping connections to protect equipment from construction dirt and debris.
- B. Preparation: Prior to installation of boilers, verify concrete housekeeping pads are complete and properly sized for boiler mounting.

### **3.2 INSTALLATION**

- A. Install and test equipment in accordance with manufacturer's instructions.
- B. Setting of equipment:
  - 1. Set boiler on concrete housekeeping pad compatible with the building structural system.
  - 2. Level boiler to within recommended tolerances.
- C. Anchoring:
  - 1. Anchor boiler to housekeeping pad.
  - 2. Coordinate with Section 13 48 00 - Vibration and Seismic Control for requirements related to seismic restraint.
  - 3. Anchoring method shall account for normal expansion and contraction of boiler.
- D. Thermal expansion:
  - 1. Install hydronic piping to allow for normal thermal expansion and contraction.
  - 2. Provide anchors where necessary and as indicated.
  - 3. Provide expansion loops, anchors and alignment guides to suit conditions and as indicated.

### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Coordinate and sequence installation of boilers with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Coordinate with Section 25 50 00 - Building Automation and Control for connection of boiler control and monitoring contact(s) and boiler circulator pump run contacts with Building Automation System.
- B. Sequences of Operation:
  - 1. Program, adjust and operationally test boiler operation and sequencing in accordance with the manufacturer's written installation and testing instructions.
  - 2. Set boilers to operate stand-alone utilizing packaged boiler controls, outdoor temperature sensor and indoor/outdoor reset schedule when set to LOCAL operation. Set aquastat to 190 Deg F supply temperature.
  - 3. Refer to Section 25 09 00 – Sequence of Operations for automatic boiler control utilizing the building automation system when set to BAS.

### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Manufacturer's Field Start-up Services:
  - 1. Start-up and provide final adjustments to the central boiler systems in accordance with the manufacturer's written boiler installation instructions.
  - 2. Operationally test safety devices and record settings.
- C. Document each equipment/system Sequence of Operation step utilizing the approved FC checklist(s) in accordance with Section 01 91 00 – Commissioning.

### **3.6 ADJUSTING**

- A. Coordinate and work directly with the requirements of Section 23 05 93 - Testing, Adjusting and Balancing to provide systems in proper operating order. Make corrections and adjustments as required by the Testing, Adjusting and Balancing (TAB) Agency in a timely manner.

### **3.7 CLEANING**

- A. After construction is completed, clean and wipe down exposed surfaces of boilers.
- B. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

### **3.8 DEMONSTRATION**

- A. Provide four hours of demonstration/operational instruction (conducted by authorized factory start-up personnel) to the DEPARTMENT's authorized maintenance personnel.
- B. Submit a letter to document that the training was conducted. Include in the letter the date, start/stop times for the training, list of attendees and signature/title of the person(s) providing the training.

**END OF SECTION 23 52 13**

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**SECTION 23 52 23**  
**CAST IRON HYDRONIC BOILERS AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Packaged hydronic fuel oil fired boilers (BLR-2 and BLR-3) and appurtenances.
  - 2. Sealed boiler exhaust venting systems.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00- Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 11 13 - Fuel Oil Piping and Specialties
  - 8. 23 21 13 - Hydronic Piping and Specialties
  - 9. 23 21 14 - HVAC Pumps
  - 10. 23 21 23 – Motors
  - 11. 25 09 00 - Sequences of Operation
  - 12. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Building Code (IBC).
- B. International Mechanical Code (IMC).
- C. International Fuel Gas Code (IFC).
- D. Uniform Plumbing Code (UPC).
- E. NFPA 54 – National Fuel Gas Code.
- F. ASME Boilers and Pressure Vessel Code (1998), Sections IV & VI.
- G. ASME CSD-1, latest edition.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. This section describes specific requirements, products and methods of execution for interrelated systems necessary for the generation of heat, which will be distributed to the locations shown. The method of distribution of this heat is specified elsewhere.
- B. Performance Requirements:
  - 1. Provide performance and output shown or scheduled on drawings.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00– Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria.
  - 2. Include the following:
    - a. Indicate which model is being submitted.
    - b. Boiler physical and performance characteristics as scheduled. Boiler physical and performance characteristics as scheduled. Include weight of equipment filled with

water. Boilers weighing more than 20 percent heavier than the schedule equipment, or if the location is different than shown, will be disapproved unless it is determined by the Department that the structure is able to bear the additional weight. Contractor may elect to increase structural support, in which case proposed changes to the structure and calculations stamped by a registered engineer shall be submitted.

- c. Dimensional data.
  - d. Features and appurtenances being provided.
- C. Shop Drawings:
1. Submit fully dimensioned shop drawings of boiler room showing major equipment and housekeeping pads, with clear callouts indicating deviations from layout shown.
  2. Submitted boiler shall be dimensionally equal to scheduled product within six (6)-inches in each dimension. Maintain clearances shown on drawings. Submit fully dimensioned shop drawings of boiler room(s) at drawing scale of 1/4-inch equals one (1)-foot zero inches or larger, showing entire boiler room, equipment and deviations. Provide boiler room modifications required due to dimensional and technical deviation at no additional cost to the Department. Submit shop drawings of proposed equipment layout and base or pad for each piece of equipment.
  3. If equipment to be provided exceeds the weight of the specified equipment by more than 20 percent, or if the location is to be altered, submit shop drawings and calculations of proposed revised structural design, noting location of pertinent loads, stamped by a registered professional engineer.
  4. Indicate mechanical and electrical service locations and requirements.
  5. Submit detailed shop drawings of boiler venting (stack) system.
- D. Quality Control/Control Submittals:
1. Start-up and Test Reports:
    - a. Provide start-up and operational test reports for each boiler.
- E. Closeout Submittals:
1. Project Record Documents: Record actual locations of equipment, piping, and components and areas required for maintenance access.
  2. Operation and Maintenance (IO&M) Manuals:
    - a. Refer to Section 20 00 00– Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
    - b. Include copies of approved submittal information within the project IO&M Manual.
    - c. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list for each piece of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - d. Include software manuals for equipment furnished under this section.
    - e. Included with the manual one (1) copy of the completed start-up and operational test report. The report shall include printed names and signatures of the installers, and documentation that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
    - f. Boiler and combustion management system startup reports.
    - g. Software Licenses for all software installed in equipment furnished under this Section.

## 1.5 QUALITY CONTROL

- A. Qualifications:
1. Manufacturer qualifications:
    - a. Company specializing in manufacturing the Products specified in this section with minimum three (3)-years documented experience.

2. Acceptable Installers:
    - a. Minimum three (3)-years experience in the installation and start-up of boilers.
  3. A factory-authorized technician shall perform boiler startup service.
  4. The manufacturer's authorized technician shall supervise the installation, startup, programming, and adjustment of the Energy Management System.
- B. Pre-Installation Meetings:
1. Fully coordinate installation of boilers and associated piping and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.
- C. Regulatory Requirements:
1. Provide automatic boiler controls listed in the Mechanical Code and ASME CSD-1, latest edition, together with most current addenda and interpretations.
  2. Provide UL listed, factory assembled, natural fuel gas train.

## 1.6 WARRANTY

- A. Refer to Section 20 00 00 for mechanical warranty requirements.

## PART 2 - PRODUCTS

### 2.1 HOT WATER BOILER - CAST IRON

- A. Provide factory-assembled, sectional, wet base, cast-iron boilers suitable for forced draft firing. The thermal output of each boiler shall not be less than and no more than 10 percent greater than the values scheduled. Required thermal capacity shall be the gross I=B=R water rating.
- B. Provide the following features:
1. Insulated metal jacket.
  2. Burner mounting plate.
  3. Gas tight seal between sections.
  4. Flue damper assembly with valved test connection.
  5. ASME safety relief valve (30 psig)
  6. Low point system drain valve with end cap.
  7. Flange mounted natural gas burner.
  8. Instrument panel for each boiler complete with the following:
    - a. Fire box draft gauge.
    - b. Stack draft gauge.
    - c. Stack temperature gauge.
    - d. Boiler supply temperature gauge.
    - e. Boiler return temperature gauge.
    - f. Burner running time totalizer.
  9. Additional components as necessary to provide a complete operational system.
- C. Manufacturers: Weil-McLain, Burnham or H. B. Smith.

### 2.2 FUEL OIL FIRED BURNERS

- A. Provide forced draft fuel oil burner sized to match boiler rating and furnished by boiler manufacturer as part of the complete boiler package.
- B. Provide fully packaged boiler and burner, with burner mounted and wired to boiler controls, complete with control transformer. Burner System shall be UL listed as a unit.
- C. Oil System: Provide burner rated for No. 2 fuel oil. Provide two pipe-oil pumps. Provide required elements for a complete system.

- D. Provide burner controls as follows:
1. Honeywell Control Links burner system to include burner brackets, full modulation oil valves and damper assemblies, aqua-stats, converters, modulation Motors, controllers, sub-bases and tool kit.
  2. Indicators and alarms to include:
    - a. Power on.
    - b. Run.
    - c. Lock out.
    - d. Low fuel pressure.
    - e. High fuel pressure.
    - f. Other indicating lights as applicable.
  3. Peripheral controls to include:
    - a. Operating temperature controller.
    - b. High limit control with manual reset.
    - c. Honeywell L4006E auxiliary high limit control.
    - d. Low water safety shut-off control.
  4. Provide dry contacts for:
    - a. Flame failure relay monitoring.
    - b. Lock out alarm.
    - c. Boiler status monitoring and control by building automation system.
  5. Honeywell Model RM-7840 Flame Safeguard System with self-diagnostic capabilities. Provide one digital display readout module to be shared by the boilers.
  6. Burner cabinet mounted 3-position switch for local burner control. Label switch positions "ON", "OFF" and "AUTO." In "AUTO" mode, burner is controlled through the Building Automation System.
  7. Provide wiring to connect boiler peripheral controls and safety devices to appropriate burner controls and building automation system in accordance with applicable provisions of Divisions 26, 27 and 28.
- E. Manufacturer: Gordon Piatt, Powerflame, Weishaupt.

### **2.3 LOW WATER CUTOFF**

- A. Provide McDonnell Miller #63M series low water cut-off for each boiler, wired in series with burner controls. Working pressure 50 psig. UL/FM approved. Provide for each boiler a McDonnell Miller TC-4 test and check assembly.

### **2.4 AUXILIARY HIGH LIMIT**

- A. Provide Honeywell Model L4006-E auxiliary high limit sensor for each boiler, wired to the building automation system.

### **2.5 BOILER VENTING (STACK) SYSTEM**

- A. Provide complete, engineered venting system for oil fired equipment, including connections and adapters to smoke outlets.
- B. Provide prefabricated chimney system of the size and configuration shown. UL listed for the application, with the following features:
1. Listed for pressurized systems.
  2. One (1)-inch fiber insulation between inner and outer stack walls.
  3. Stainless steel liner, and stainless steel outer jacket where exposed to outdoor weather.
  4. Clearances from building elements in accordance with chimney listing.
- C. Provide clean-out tee, insulating roof support, and other appropriate appurtenances required for proper installation and as recommended by manufacturer. Include stainless steel flashing and counter flashing.
- D. Supports and seismic restraints in accordance with the manufacturer's UL listing.

- E. Manufacturers: Selkirk Metalbestos, AMPCO (American Metal Products Company), Cleaver Brooks, ICC (Industrial Chimney Company), Schebler, Van Packer.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection:
  - 1. Cover boilers and burners and plug piping connections to protect equipment from construction dirt and debris.
- B. Preparation:
  - 1. Prior to installation of boilers, verify concrete housekeeping pads are complete and properly sized for boiler mounting.
  - 2. Prior to installation of stacks, verify that shop drawings are approved and stack locations and routing has been coordinated with other trades.

#### **3.2 INSTALLATION**

- A. Install equipment in accordance with manufacturer's instructions.
- B. Setting of equipment:
  - 1. Set equipment on concrete housekeeping pads compatible with the building structural system. Level equipment to within recommended tolerances.
- C. Anchoring:
  - 1. Anchor equipment to building structure. Coordinate with Section 20 05 29 - Hangers and Supports and Section 13 48 00 - Vibration and Seismic Control for requirements related to seismic restraint. Anchoring method shall account for normal expansion and contraction of equipment.
- D. Thermal expansion:
  - 1. Install hydronic piping to allow for normal thermal expansion and contraction. Provide anchors where necessary and as indicated. Provide expansion loops, anchors and alignment guides to suit conditions and as indicated.
- E. In systems containing glycol, provide only products specifically designed and approved for continuous operation with the glycol solution specified.
- F. Provide low point drain valve with capped hose bibb and chase rated access door for stack low point drain.
- G. Refer to Section 20 05 53 - Mechanical Identification for boiler labeling requirements.
- H. Refer to Section 23 21 13 - Hydronic Piping and Specialties for piping requirements.
- I. Refer to Section 23 11 13 - Fuel Oil Piping and Specialties for fuel piping installation.
- J. Refer to Sections 25 50 00 - Building Automation and Control and 25 09 00 - Sequence of Operation for connection to the building automation system.

#### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Fully coordinate and sequence installation of boilers and stacks with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

#### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.

- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Manufacturer's Field Start-up Services:
  - 1. Start-up and adjust the system to within the tolerances as specified by the equipment manufacturer.
  - 2. Operationally test safety devices and record settings. Test and record oxygen, carbon dioxide, stack temperature, and calculate excess air and steady state efficiency. Make final lead/lag setpoint adjustments. List setpoints in report. Submit final data for review. Provide two (2) hours operating instruction to authorized Department's personnel by factory start-up personnel.
  - 3. Test boiler operation and sequencing in accordance with the manufacturer's written installation and testing instructions and Section 25 09 00 – Sequence of Operations.
  - 4. Provide a start-up report that includes final control settings, and a performance chart of the control system furnished.
  - 5. Submit a letter of certification with copy of start-up report, indicating that the boiler start-up has been completed, that the boilers are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the Sequence of Operation is fulfilled.

### **3.6 ADJUSTING**

- A. Fully coordinate and work directly with the requirements of Section 23 05 93 - Testing, Adjusting and Balancing to provide systems in proper operating order. Make corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

### **3.7 CLEANING**

- A. After construction is completed, clean and wipe down exposed surfaces of boilers and burners.
- B. Touch up marred or scratched factory finished surfaces using finish materials furnished by manufacturer.

**END OF SECTION 23 52 23**

**SECTION 23 64 00**  
**PACKAGED WATER CHILLERS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes
  - 1. Water-cooled chiller (CH-1).
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 14 - HVAC Pumps
  - 9. 25 09 00 - Sequences of Operation
  - 10. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).

**1.3 SYSTEM DESCRIPTION**

- A. The water cooler chiller serves the AHU-6 chilled water cooling coil (CC-6). The AHU-6 air handling systems requires a lower chilled water supply temperature than the other chilled water cooling coils in the system due to the additional dehumidification requirements of this 100 percent outside laboratory ventilation system.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria.
  - 2. Include the following:
    - a. Indicate which model is being submitted.
    - b. Chiller physical and performance characteristics as scheduled.
    - c. Dimensional data.
    - d. Features and appurtenances being provided.
- C. Shop Drawings:
  - 1. Include scaled chiller (dimensions per approved product submittal), housekeeping pad and associated chilled water system and electrical connections with fan room shop drawing submittal to demonstrate proper fit and maintenance access.
- D. Quality Control/Control Submittals:
  - 1. Start-up and Test Reports: Provide start-up and operational test report.
- E. Closeout Submittals:
  - 1. Project Record Documents: Record actual locations of chiller, piping, and areas required for maintenance access.

- F. Operation and Maintenance (IO&M) Manuals:
- a. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
  - b. Include copies of approved submittal information within the project IO&M Manual.
  - c. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list. Clearly annotate the manual to indicate applicable information for the specific chiller model installed.
  - d. Included with the manual one (1) copy of the completed start-up and operational test report. The report shall include printed names and signatures of the installers, and documentation that the equipment has been properly installed and is fully operational, thus validating the chiller warranty.

## 1.5 QUALITY CONTROL

- A. Qualifications:
1. Manufacturer qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3)-years documented experience.
  2. Acceptable Installers: Minimum three (3)-years experience in the installation and start-up of chillers.
- B. Regulatory Requirements:
1. Chiller constructed in accordance with UL 1995 and NEC standards and UL or ETL labeled.
  2. Chiller ratings tested in accordance with ARI 550/590 – Standard for Water Chilling Packages.
  3. Chiller meets ANSI/ASHRAE 15 – Safety Standard for Refrigerated Systems safety standards.
- C. Pre-Installation Meetings:
1. Fully coordinate installation of the chiller and associated piping and equipment with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

## 1.6 WARRANTY

- A. Refer to Section 20 00 00 - Mechanical General Requirements for mechanical warranty requirements.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units on site from physical damage after unloading.

## PART 2 - PRODUCTS

### 2.1 PACKAGED CHILLER

- A. General:
1. Integral epoxy coated steel frame with epoxy painted aluminum panels.
  2. Dual refrigeration circuits for partial redundancy.
  3. Shipped complete with the test charge of R-410A.
  4. Factory tested for capacity prior to shipment.
- B. Cabinet:
1. Epoxy coated aluminum panels on aluminum frame.
  2. Easily removable access panels for service using stainless steel fasteners with retaining clips.

- C. Compressor: Hermetically sealed scroll compressor with service valves, crankcase heaters, suction gas cooled motors with solid-state sensors (in windings) for overload protection and in-line fusing. Frame mounted with rubber-in-shear isolators.
- D. Evaporator: Stainless steel brazed plate evaporator with 316 stainless steel plates and copper brazing. Insulated with ¾" closed cell insulation. Minimum working pressure: 650 PSIG.
- E. Condenser: Coaxial type water-cooled condenser with copper inner water tube and steel outer jacket. Seamless copper water tubing; convoluted to increase turbulence and heat transfer surface area. Minimum working pressure: 400 PSIG.
- F. Condenser circuit water regulating valve: Two-way water- regulating valve on each independent refrigeration circuit to regulate refrigeration head pressure. Minimum working pressure: 150 PSIG.
- G. Refrigerant piping: Two, independent refrigeration circuits. Type K copper tubing with insulated suction line, hot gas bypass capacity control, compressor service valves, condenser water regulating valve, receiver for system pump down, solenoid valve for liquid line isolation, and shradler service valves on suction, liquid and hot gas lines.
- H. Water Piping: All copper water lines insulated to prevent condensation. Built in valves and unions for ease of component isolation and service.
- I. Packaged Controls: Provide stand-alone microprocessor based controller for all chiller operations. Include operational switches for each pump and compressor, water flow safety switch, high and low refrigeration pressure switches, low pressure pump down switch, anti-short cycling compressor timer, minimum compressor run timer, phase monitor ( to protect against low voltage, phase unbalance, phase loss and phase reversal conditions). The microprocessor shall alternate compressor lead/lag operation on a weekly basis to provide even run time between compressors.
- J. Microprocessor: The microprocessor shall provide the following minimum functions:
  - 1. Adjustable leaving fluid temperature set point
  - 2. High and low fluid temperature alarm set points
  - 3. Switchover to backup supply set points
  - 4. Field adjustable compressor alternating time
  - 5. Alarm logging with minimum of previously 100 logged alarms with time and date of each occurrence
  - 6. Remote start stop input to BAS.
  - 7. Dry contact for general alarm monitoring from BAS.
- K. Manufacturers: ArctiChill (Basis of Design) or pre-approved equal.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Planning: Prepare and submit fan room shop drawings to confirm chiller fit.
- B. Protection:
  - 1. Maintain access panels shut and piping connections capped to protect components from construction dirt and debris.
- C. Surface Preparation:
  - 1. Provide clean and level housekeeping pad to support equipment.

### **3.2 INSTALLATION**

- A. Install chiller in compliance with the manufacturer's written installation instructions, approved shop drawings and the following:
  - 1. Install hydronic cooling piping in accordance with Section 23 21 13 – Hydronic Piping and Specialties. Provide installation and connection of additional sensors and safety devices as recommended by the chiller manufacturer for proper operation of the unit.
  - 2. Install BAS control and monitoring wiring in accordance with Section 25 50 00 – Building Automation and Control.
  - 3. Install electrical power and wiring in accordance with Divisions 26, 27 and 28.
  - 4. Support chiller base frame on concrete housekeeping pad. Center unit on housekeeping pad to provide an equal housekeeping pad lip around the unit.
  - 5. Seismically anchor base frame to housekeeping pad/structure at each base frame lug using anchor bolts appropriate for the installation in accordance with Section 13 48 00 - Vibration and Seismic Control.

### **3.3 CONSTRUCTION**

- A. Interface with other Work:
  - 1. Coordinate and sequence installation the chiller with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

### **3.4 REPAIR/RESTORATION**

- A. Repair product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.6 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down internal and external surfaces.

### **3.7 SYSTEM STARTUP**

- A. Charge chiller system with refrigerant. Test system for leaks after completion of installation. Repair leaks, place system in service and operationally test to field verify chiller performance.
- B. Start-up and operate chiller in accordance with the manufacturer's written installation, operation and maintenance manuals.
- C. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

### **3.8 ADJUSTING**

- A. Coordinate the testing, adjusting and balancing of the chiller with the operation of air handling unit AHU-6 in accordance with Section 23 05 93 – Testing, Adjusting and Balancing, the manufacturer's recommendations and as otherwise directed by the Department's Representative.

**END OF SECTION 23 64 00**

**SECTION 23 70 00**  
**CENTRAL AIR HANDLING UNITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Central air handling units.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 14 - HVAC Pumps
  - 9. 23 31 00 - Ducts and Accessories
  - 10. 23 40 01 - Duct Cleaning
  - 11. 23 84 00 - Humidification Equipment
  - 12. 25 09 00 - Sequences of Operation
  - 13. 25 50 00 - Building Automation and Control
  - 14. 25 55 00 - Variable Speed Drives

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. AMCA 99 (Air Movement and Control Association) - Standards Handbook.
- C. ASHRAE Handbook 2003 HVAC Applications, Chapter 47 – Sound and Vibration Control.
- D. ASHRAE Standard 90.1-2003 Energy Standard for Buildings Except Low-Rise Residential Buildings.

**1.3 SYSTEM DESCRIPTION**

- A. This section describes the custom central air handling equipment for the project.

**1.4 SUBMITTALS**

- A. Product Data:
  - 1. Provide submittal data in accordance with the general requirements of Section 20 00 00 - Mechanical General Requirements. Include the additional submittal information specific to the equipment specified by this section as followings:
    - a. Provide manufacturer's literature that fully demonstrates compliance with the manufacturing methods, appurtenances and salient features specified.
    - b. Provide fully labeled fan curve(s) with system curve and operating point clearly plotted. For variable speed Fans, provide fan curves for both minimum and maximum operating points.
    - c. Provide custom sound power level data (decibels) for each octave band for fan inlet, fan discharge and radiated sound power of the assembled air handling unit as shown. Determine sound level data using one of the following methods:
      - 1). Actual measurements from tests performed in accordance with AMCA Standards in an AMCA registered test chamber.
      - 2). Documented calculations that start with AMCA tested fan sound data and are modified in accordance with 1999 ASHRAE HVAC Applications, Chapter 46

- Sound and Vibration Control accurately predict the sound power levels for the configuration shown.
- d. Provide electrical connection requirements.
  - e. Provide electrical power connection and control logic wiring diagrams. Diagrams must differentiate between factory installed and field-installed wiring.
  - f. Provide internal fan vibration, seismic support equipment selection approved by the seismic design engineer in accordance with Section 13 48 00 – Vibration and Seismic Control.
- B. Substitutions:
- 1. Cost of design modifications as a result of proposed product substitutions shall be borne by the Contractor.
- C. Shop Drawings:
- 1. Provide dimensional and orientation information (plan and elevation) for the approved central air handling unit(s) incorporated into the ventilation system shop drawings.
  - 2. Indicate actual cabinet location, sectional and overall cabinet dimensions, housekeeping pad perimeter, mixing box damper sizes and arrangement, access door locations, access clearances for filter, coil and fan replacement, duct connections, and electrical connection points.
  - 3. Coordinate supply fan discharge plenum floor penetrations and return fan/exhaust fan roof penetrations with structural. Exhaust fan vertical stack/relief hood alignment is critical as is coil/filter pull space align with the buildings support columns.
  - 4. Label overall air handling units as scheduled. Label each cabinet section as specified.
  - 5. Provide fan cabinet anchoring method approved by the seismic design engineer in accordance with Section 13 48 00 – Vibration and Seismic Control.
- D. Operation and Maintenance (IO&M) Manual:
- 1. Provide a complete copy of the manufacturer's written installation, operation and maintenance manual to include the following information:
    - a. Manufacturer's descriptive literature.
    - b. Installation instructions.
    - c. Operating instructions.
    - d. Troubleshooting guide.
    - e. Preventative maintenance requirements.
    - f. Complete parts list.
    - g. Recommended spare parts list.
  - 2. Neatly annotate the IO&M manual to clearly indicate information applicable to the equipment installed.
- E. Closeout Submittals:
- 1. Project record drawings:
    - a. Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation of the Central Air Handling Units.
  - 2. Provide a certificate from the Manufacturer's Representative indicating that the Central Air Handling Units are installed and operational in accordance with the manufacturer's written installation, operation and maintenance manual.

## 1.5 QUALITY CONTROL

- A. Manufacturer qualifications:
- 1. Company specializing in manufacturing the products specified in this section with a minimum of three (3) years documented experience.
- B. Installers' qualifications:
- 1. Minimum three (3) years experience in the installation and start-up of custom central air handling systems.

- C. Regulatory requirements:
  - 1. Products requiring electrical connection: Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Municipality.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Acceptance at Site:
  - 1. Verify central air handling unit(s) and associated appurtenances are delivered in original factory packaging/crating and are free from damage and corrosion.
  - 2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Department.
- B. Storage and Protection:
  - 1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

## **1.7 WARRANTY**

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements.

## **PART 2 - PRODUCTS**

### **2.1 SUPPLY, RETURN AND EXHAUST AIR HANDING UNIT MANUFACTURERS**

- A. Scott-Springfield
- B. Mafna
- C. Haakon.
- D. Approved Equal.

### **2.2 CENTRAL SUPPLY AIR HANDING UNITS (AHU-1 THRU AHU-5)**

- A. Provide Central Air Handling Unit of size and configuration as scheduled and shown with the following sectional components:
  - 1. Inlet Plenum Section
  - 2. Pre-Filter, Final Filter and Carbon/Dusting Filter Sections
  - 3. Hydronic Heating Coil Section
  - 4. Hydronic Cooling Coil Section
  - 5. Humidification Dispersion Panel Section
  - 6. Supply Fan Section
  - 7. Plenum Sections as shown.
  - 8. Custom Discharge Plenum (with through floor penetrations as shown)
- B. Dimensions: Actual cabinet/base rail dimensions may differ slightly. Prior to submitting equipment verify that the unit will adequately fit in the space provided with proper access for operation and maintenance to include the removal/replacement of components and filters.

### **2.3 CENTRAL LABORATORY AIR HANDING UNIT (AHU-6)**

- A. Provide Central Air Handling Unit of size and configuration as scheduled and shown with the following sectional components:
  - 1. Supply Fan:
    - a. Inlet Plenum (100% Outside Air)
    - b. Summer Filter Rack (MERV 8)
    - c. Preheat Coil section
    - d. Winter Filter Rack (MERV 8)
    - e. Enthalpy Wheel
    - f. Final Filter and Carbon/Dusting Filter Sections
    - g. Cooling Coil Section

- h. Heating Coil Section
  - i. Fan Section
  - j. Plenum Sections as shown.
  - k. Custom Discharge Plenum (with through floor penetration) and bell mouth duct fittings.
2. Exhaust Fan:
- a. Custom Inlet Plenum with bell mouth duct connection.
  - b. Filter Rack (MERV 8)
  - c. Enthalpy Wheel
  - d. Exhaust Fan Section with top mounted exhaust stack connection. Fabricate stack connection flange to mate with stack manufacturer's stack section connector system.
  - e. Plenum Sections as shown.
- B. Dimensions: Actual cabinet/base rail dimensions may differ slightly. Prior to submitting equipment verify that the unit will adequately fit in the space provided with proper access for operation and maintenance to include the removal/replacement of components and filters.

## 2.4 SECTIONAL AIR HANDLING UNIT COMPONENTS

- A. Dimensions: Size each section to match overall cabinet height and width.
- B. Unit casing construction
- 1. Structural steel channel base frame with anchoring lugs.
  - 2. Heavy gauge steel cabinet, reinforced, and braced with steel angle framing for maximum rigidity.
  - 3. Acoustically lined cabinet interior with four (4)-inch thick UL listed acoustical liner materials.
  - 4. Solid or perforated galvanized steel interior cabinet wall and ceiling liner as specified.
  - 5. Diamond plate interior floor throughout with low point drain(s).
  - 6. Exterior casing, base frame and accessories coated with baked enamel finish.
  - 7. Internal components and accessories coated with baked enamel finish or galvanized steel.
  - 8. Connect parts with plated, galvanized steel fasteners.
  - 9. Provide general cabinet floor drain with exterior threaded and bronze end cap. Provide drain pan under each coil section with capped external drain connection to accept trapped indirect drain piping.
  - 10. Provide steel stamped nameplate with air handler performance date clearly indicated.
- C. Inlet Plenum Section
- 1. Twenty gauge solid galvanized steel interior wall and ceiling liner.
  - 2. Hinged, insulated, double walled access door.
  - 3. Interior lighting with wall switch for maintenance and general cleaning.
  - 4. Air Control Dampers (AHU-6 only):
    - a. Manufacturer: TAMCO, Model 9000 (No substitutes).
    - b. Low leakage, heavy gauge, internally insulated, extruded aluminum, air foil blades with extruded EDPM blade gaskets and frame seals.
    - c. Insulated aluminum frame with parallel blade action.
    - d. Damper Sizing: Size dampers for maximum scheduled AHU air flow rate (CFM) using a flow velocity of 1,500 FPM not to exceed 0.1-inch static pressure drop with damper fully open.
    - e. Damper Arrangement: Provide dampers, factory installed and sealed to the mixing box as indicated.
- D. Filter Section
- 1. Twenty gauge solid galvanized steel interior wall and ceiling liner.
  - 2. Hinged, insulated, double walled access door.

3. Factory installed, galvanized steel, gasketed, filter frames and assembly modules to support the installation of the filter media specified in 24" x 24" and 24" x 12" modules in the arrangements shown:
- E. Heating Coil Section
1. Cabinet:
    - a. Twenty gauge solid galvanized steel interior wall and ceiling liner with sloped drip pan and capped drain plug with hose adapter.
    - b. Sloped, galvanized steel drip pan with capped drain plug and drain hose adapter.
    - c. Provide split casing panel to facilitate coil removal. Coordinate panel location with coil access and coil piping.
  2. Heating Coil:
    - a. Provide coil with scheduled operational performance characteristics.
    - b. Coils designed for counter-flow heat transfer with equal pressure drop through each circuit.
    - c. Working Pressure: 250 PSIG.
    - d. Primary surface:
      - 1). Round, seamless, 5/8 inch O.D. x 0.025 inch thick copper tubing.
      - 2). Tubes mechanically expanded into fins over the entire finned length.
      - 3). Brazed joints.
    - e. Secondary surface:
      - 1). Solid aluminum fins (no punched openings to accumulate lint and dirt) with full drawn collars (Bare copper tube not visible between fins).
      - 2). Fin thickness: 0.0095 inches.
    - f. Coil Casing:
      - 1). Continuous 16 gauge galvanized steel with reinforced flange type side plates.
    - g. Coil Headers:
      - 1). Seamless, copper tubing.
      - 2). Low point coil drain and high point coil vent.
    - h. Coil Casing:
      - 1). Continuous 16 gauge galvanized steel with reinforced flange type side plates.
- F. Cooling Coil Section
1. Cabinet:
    - a. Twenty gauge solid galvanized steel interior wall and ceiling liner with sloped drip pan and capped drain plug with hose adapter.
    - b. Sloped, galvanized steel drip pan with capped drain plug and drain hose adapter.
    - c. Provide split casing panel to facilitate coil removal. Coordinate panel location with coil access and coil piping.
  2. Cooling Coil:
    - a. Provide coil with scheduled operational performance characteristics.
    - b. Coils designed for counter-flow heat transfer with equal pressure drop through each circuit.
    - c. Working Pressure: 250 PSIG.
    - d. Primary surface:
      - 1). Round, seamless, 5/8 inch O.D. x 0.025 inch thick copper tubing. Tubes mechanically expanded into fins over the entire finned length.
      - 2). Brazed joints.
    - e. Secondary surface:
      - 1). Solid aluminum fins (no punched openings with full drawn collars (Bare copper tube not visible between fins).
      - 2). Fin thickness: 0.0095 inches.
    - f. Coil Casing:
      - 1). Continuous, 16 gauge galvanized steel with reinforced flange type side plates.

- g. Coil Headers:
  - 1). Seamless, copper tubing.
- G. Humidification Section
  - 1. Provide humidification section to allow the installation of steam dispersion panels and associated brackets/drain pans. See unit casing construction requirements.
  - 2. Twenty gauge solid galvanized steel interior wall and ceiling liner.
  - 3. Hinged, insulated, double walled access door.
  - 4. Provide factory installed humidification dispersion unit with scheduled operational performance characteristics. See Section 23 84 00 – Humidification Equipment for detailed humidification system specifications.
  - 5. Provide sufficient section length downstream of dispersion unit to allow full absorption of water vapor through full range of operating conditions prior to entering fan inlet.
- H. Energy Recovery (Enthalpy) Wheel Section (AHU-6 only)
  - 1. Provide rotary air-to-air heat exchanger wheel with the performances and efficiencies as scheduled. Flame-spread rating: 25 or less. Smoke-developed rating: 50 or less. Performance certified by AHRI Standard 1060.
  - 2. Rotor
    - a. Constructed of smooth and corrugated aluminum sheets interwoven to form a wheel, creating a large number of axial passages through which the air flows. A smooth flange attached to the outer diameters of the wheel provides a smooth surface for the peripheral seal is installed. Axial wheel passages must be capable of passing 1000-micron particles.
    - b. The aluminum rotor surfaces shall be treated for corrosion resistance and include a low co-adsorption ion exchange resin media to adsorb and transfer humidity in the vapor phase. Coat the substrate and resin with a permeable anti-mold/mildew treatment.
    - c. The rotor shall be capable of withstanding cleaning by vacuum cleaner, with water and detergent or with low-pressure compressed air.
    - d. Provide rotor surfaces ground and polished smooth for long seal life and to prevent annular cross contamination between air streams.
    - e. Provide segmented rotor construction for rotors more than 68 inches in diameter (four (4) sections). For rotors more than 114 inches in diameter, provide a minimum of six and a maximum of 8 sections.
    - f. Support sections in place as pie segments contained by peripheral channels formed together, and to adjoining sections and to the hub such that bypassing of air around the peripheral channels will not occur. Wheel segments shall be readily removable and replaceable in the field.
  - 3. Rotor Cassette
    - a. Provide a 10 gauge (minimum) steel rotor cassette with built-in purge section to provide minimum cross contamination of exhaust air.
    - b. Include built-in purge section to limit exhaust air carry-over into the outside supply air stream to 0.04% when operated under design conditions.
    - c. Isolate supply and exhaust air streams using adjustable seals secured to the cassettes panels and duct dividers. The seals shall consist of a double layer of neoprene wiper seals, labyrinth or brush seals. Wiper and bush seals shall be installed in contact with the wheel flange in order to minimize leakage between the supply and exhaust air systems. Labyrinth seals shall be installed with a minimum gap between the seal and the wheel flange.
    - d. Provide corrosion resistant powder coating for all metal parts exposed to the air streams.
  - 4. Rotor Drive System
    - a. Support rotor with ball bearing type hub supports and rotate rotor wheel with belt driven, factory mounted, electric drive motor with VSD speed controller.
  - 5. Rotation Failure Detector: Provide a factory mounted rotation detection device that communicates with the VSD speed controller and includes a relay connected to the BAS.

In the event of a rotor drive system failure, send a "AHU-6 Enthalpy Wheel Trouble" alarm to the BAS.

- I. Fan Section
  1. Cabinet:
    - a. Twenty gauge perforated galvanized steel interior wall and ceiling liner.
    - b. Hinged, insulated, double walled access door.
    - c. Interior lighting with wall switch for maintenance and general cleaning.
    - d. Sloped, galvanized steel drip pan with capped drain plug and drain hose adapter.
  2. Fan Manufacturers:
    - a. Twin City.
    - b. Greenheck.
    - c. Cook.
    - d. Barry Blower.
  3. General Fan Requirements:
    - a. Provide factory assembled, balanced and tested fan arrays of the size, type and capacity scheduled. Provide each fan module with a separate and independent shut-off style motor operated back draft damper.
    - b. AMCA listed and labeled.
    - c. Provide factory applied enamel coating system to fan assembly components (except aluminum).
    - d. Provide fan arrangement with accessibility for complete cleaning, component replacement and preventative maintenance. Provide grease fitting(s) with extended grease lines (as necessary for direct access).
  4. Vibration Isolation:
    - a. Isolate fan frames from unit casing using stable spring vibration isolators.
      - 1). Manufacturer: Mason Industries.
    - b. Isolate fan vibration from inlet nozzle with flexible airtight joint.
      - 1). UL Listed, vinyl coated, woven nylon/polyester blend fabric with double folded seam and galvanized steel edging.
      - 2). Manufacturer: Duro-dyne Corporation (Basis of Design), Vent Fabrics or approved equal.
    - c. Bearings:
      - 1). Greater than 200,000 hours average rated life at rated load and speed specified.
  5. Fan Drives:
    - a. Direct drive.
  6. Motors:
    - a. Provide Motors of size, voltage and phase indicated. Provide other characteristics in accordance with Section 23 21 23 - Motors.
  7. Sound data:
    - a. Factory test fan assemblies to determine suction, discharge and radiated sound levels (decibels) for each octave band in accordance with AMCA Standards. Include sound level data with fan Submittals.
    - b. When sound ratings are not specified, physical characteristics including type, wheel diameter and fan speed shall be the basis of comparison with specified requirements.
    - c. Octave band sound power levels shall not exceed those scheduled.
  8. Air flow Monitoring Stations:
    - a. Manufacturer:
      - 1). Air Monitor Corporation or pre-approved equal.
      - 2). Model: Volu-Probe/FI.
    - b. Multi-port, self averaging airflow probes with integral airflow direction correcting design.
    - c. Provide separate factory mounted airflow monitoring station each fan.

- d. Mount velocity probes directly to fan inlet cone or bell-mouth.
- e. Accuracy: Three percent.
- J. Plenum Section:
  - 1. Provide plenum sections between coils and at fan inlets as shown. Construct plenum cabinets to the same specifications as unit casing construction.
  - 2. Twenty gauge perforated galvanized steel interior wall and ceiling liner.
  - 3. Hinged access door and interior lighting for maintenance and general cleaning.
- K. Discharge/Intake Plenum Section:
  - 1. Provide custom supply air discharge and return air intake plenums for supply and return air handling units. Fabricate custom discharge plenums (including supply plenums which pass through fan room floors to second floor ceiling plenum) to the same material, fabrication and quality standards as other cabinet sections.
  - 2. Twenty gauge perforated galvanized steel interior wall and ceiling liner.
  - 3. Hinged access door and interior lighting for maintenance and general cleaning.
  - 4. Provide open galvanized steel floor grating at main cabinet deck level above lower floor discharge plenum sections. Provide 1 inch raised steel rim around lower discharge plenum section floor penetrations to prevent water from running down into lower plenum.
- L. Enthalpy Wheel Section (AHU-6)
  - 1. To be written.

## 2.5 DUCT MOUNTED SILENCERS:

- A. Provide fan silencers of the size and performance characteristics as scheduled. Locate silencers in supply/return air handling unit cabinets configured as shown.
- B. Performance of silencers including dynamic insertion loss, self-noise and pressure loss shall be determined by the manufacturer and certified in accordance with ASTM Standard E477-96 or later issue. Compliance with ADC Standard 1062R3 is also required, except where this would result in lower performance than ASTM E-477.
- C. Silencer requirements shall not be reduced from specified attenuation.
- D. Construction:
  - 1. Solid galvanized steel outer shell.
  - 2. Mylar sheeting/bagging to contain the mineral fiber absorption material.
  - 3. Perforated galvanized steel sound baffle inner liner.
- E. Basis of Design duct silencers selected with regard to practical limits of pressure loss and self-noise. Proposed substitutions or changes shall be selected in accordance with the above considerations.
- F. Manufacturers:
  - 1. IAC (Basis of Design)
  - 2. Rink
  - 3. Haakon

## 2.6 AIR FILTERS

- A. Pre-Filters and Dusting Filters
  - 1. Manufacturers:
    - a. Camfil Farr 30/30 (MERV8) (Basis of Design).
    - b. American Air Filter.
    - c. Pre-approved equal.
  - 2. Provide disposable, pleated dry media filters having an average efficiency of 25 percent to 30 percent when tested in accordance with ASHRAE 52.1-1992 with an average arrestance of 90 percent to 92 percent.
  - 3. Complete filter UL listed as Class 2 air filter.

4. Filter shall be constructed from pleated media supported and bonded to welded wire grid within a rigid beverage board frame. Media shall be non-woven, reinforced cotton and synthetic fabric. Media shall provide not less than 4.6 square feet of filter area for each square foot of face area. Media and frame shall be bonded to prevent air leakage.
  5. Design of filter bank shall be based on an airflow rate of not more than 350 CFM per square foot of gross face area unless otherwise indicated. Initial static pressure loss shall not exceed 0.08 inches water column at 250 feet per minute face velocity. Filter shall be designed to operate at up to 0.9 inch water column, if required.
  6. Preferred filter sizes are 24 by 24 by 2 inches and 24 by 12 by 2 inches. Filter banks for component air handlers and unitary equipment shall be designed to use the minimum number of readily available standard filter sizes. Cabinet unit heaters, fan coil units, and similar units may be fitted with one (1) inch thick filters if not designed to accommodate 2 inch thick filters.
- B. Secondary Filters
1. Manufacturers:
    - a. Camfil/Farr, E-Series RIGA-FLO (MERV 14) (Basis of Design)
    - b. American Air Filter.
    - c. Pre-approved equal.
  2. Provide high performance, preformed, deep pleated, rigid disposable type dry media filters having an average efficiency of 80 to 85 percent when tested in accordance with ASHRAE 52.1-1992 and an average arrestance of not less than 97.5 percent (standard test) and 12 percent (0.3 micron duct).
  3. Complete filter shall be UL listed as a Class 2 air filter
  4. Non-steel construction. Moisture-resistant, rustproof housing, Non-woven polypropylene micro-fiber filter media with stiffened backing. Rigid grille and contour stabilizer supports to prevent oscillation and sagging of media.
  5. Size filter bank for 500 FPM airflow velocity. Initial static pressure not to exceed 0.41 inches water column at 500 feet per minute face velocity. Filter shall be designed to operate at up to 1.5 inches water column (manufacturer's recommended final resistance).
  6. Preferred filter sizes are 24 by 24 by 12 inches deep and 24 by 12 by 12 inches deep. Filter banks shall be designed to use the minimum number of readily available standard filter sizes.
- C. Carbon Filters and Modular Housing Assemblies
1. Manufacturers:
    - a. Camfil/Farr (Basis of Design)
    - b. American Air Filter.
    - c. Pre-approved equal.
  2. Carbon Media
    - a. One (1) inch deep loose-fill stainless steel panels designed for use with Camsorb CF4A modules.
    - b. Media: Activated carbon.
    - c. Maximum continuous operating temperature: 155 Deg F.
    - d. Mfr: Camfil/Farr, Model: CamSorb 1" CF
- D. Modular Filter Housing Assemblies:
1. Manufacturers:
    - a. Camfil/Farr (Basis of Design)
    - b. American Air Filter.
    - c. Pre-approved equal.
  2. Pre-filter, final filter and dusting filter frame construction:
    - a. Welded galvanized steel reinforced with bracing and corner gussets and sealed to prevent leakage.
    - b. Gaskets in filter frames of closed cell synthetic rubber and positive spring type clamps to hold filter securely against gaskets.

- c. Access for changing filters from one or both sides of housing. Walk-in plenums shall have access for changing filter from dirty side.
  - d. Side access filter units consisting of a separate frame for each filter, sliding on tracks with a gasket system shall be provided where indicated. Standard manufactured system shall be used.
  - e. Sixteen (16) gauge galvanized steel frames with gasketed filter seal flanges, multiple lances for application of various fasteners to accommodate 2" and 12" deep filters specified. Pre-drilled holes for bank assembly, marked top for ease of installation.
  - f. Compatible with carbon absorber modules.
3. Carbon filter frame construction:
- a. Sixteen (16) gauge absorber modules with tracks for 12 polystyrene trays between two universal holding frames designed for the attachment of secondary filters art inlet and final dusting filter frames at discharge.
  - b. Modules stacked up to six modules high by any number of modules wide and available in 24" by 24" or 12" by 24" dimensions.
  - c. Mfr: Camfil/Farr, Model: CamSorb CF4A
4. Filter frames within an air handling unit shall be provided by manufacturer.
- E. Filter Gauges:
1. Provide a dial type gauge with diaphragm magnetically coupled to pointer and with connections to upstream and downstream static pressure probes. A single gauge may be used to measure the pressure drop of pre-filter/final filter combinations if 3-way valves are used to measure each bank independently.
  2. Coordinate with Controls work to connect filter monitoring pressure switches to same probes as the gauge.
  3. Gauge scale range shall be 0 to 1 inch water column for medium efficiency filters pre-filters and 0 to 2 inch water column for final filters.
- F. Filter Quantities:
1. Provide a new complete set of MERV 8 filters for use during construction.
  2. Provide a complete set of all filter types for use during system Testing, Adjusting and Balancing.
  3. Provide one set of spare MERV 8 and MERV 14 filter elements in original sealed factory boxes for each air handling, return fan and exhaust fan unit.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Planning: Air handling unit coordination with Architectural and Structural components is critical. Floor penetrations and coil/filter pull out clearances are critical and are coordinated with internal building roof support columns. Prepare and submit fan room shop drawings to confirm AHU fit and penetration locations. Do not order air handling units without approved shop drawings.
- B. Protection:
1. Maintain access doors shut, air handler box dampers and supply duct connections covered and drain connections capped to protect components from construction dirt and debris.
  2. Protect return air inlet with MERV 8 filters during construction.
- C. Surface Preparation:
1. Provide clean and level housekeeping pad to support equipment.

#### **3.2 INSTALLATION**

- A. Install air handlers units in compliance with the manufacturer's written installation instructions, approved shop drawings and the following:
1. Install ductwork accordance with Section 23 31 00 – Ducts and Accessories.

2. Install hydronic heating and cooling piping in accordance with Section 23 21 13 – Hydronic Piping and Specialties.
3. Install steam humidification piping in accordance with Section 23 84 00 – Humidification Equipment.
4. Install BAS actuators, sensors, controls and control wiring in accordance with Section 25 50 00 – Building Automation and Control.
5. Install electrical power and wiring in accordance with Divisions 26, 27 and 28.
6. Support central air handling unit base frames on concrete housekeeping pads. Center units on housekeeping pads to provide an equal housekeeping pad lip around each unit.
7. Seismically anchor base frame to housekeeping pad/structure at each base frame lug using anchor bolts appropriate for the installation in accordance with Section 13 48 00 - Vibration and Seismic Control.
8. Locate hydronic piping connections and drip pan drains on same side of units as floor drain.
9. Trap cooling coil condensate drains and pipe to indirect funneled floor drains. Provide adequate trap height to compensate for fan cabinet pressure differentials.

### **3.3 CONSTRUCTION**

- A. Interface with other Work:
  1. Coordinate and sequence installation air handling units with trades responsible for portions of this and other related sections of the Project Manual.
  2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

### **3.4 REPAIR/RESTORATION**

- A. Repair product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.6 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down internal and external surfaces.

### **3.7 SYSTEM STARTUP**

- A. Start-up and operate air handling units in accordance with the manufacturer's written installation, operation and maintenance manuals.
- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

### **3.8 ADJUSTING**

- A. Test, adjust and balance air handling equipment in accordance with Section 23 05 93 – Testing, Adjusting and Balancing, the manufacturer's recommendations and as otherwise directed by the Department's Representative.

**END OF SECTION 23 70 00**

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**SECTION 23 72 13**  
**DEDICATED OUTSIDE AIR UNITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes:
  - 1. Roof mounted dedicated outside air units.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 07 72 00 - Roof Accessories
  - 3. 13 48 00 - Vibration and Seismic Control
  - 4. 20 00 00 - Mechanical General Requirements
  - 5. 20 05 29 - Hangers and Supports
  - 6. 20 05 53 - Mechanical Identification
  - 7. 20 07 00 - Mechanical Insulation
  - 8. 23 05 93 - Testing, Adjusting and Balancing
  - 9. 23 21 23 - Motors
  - 10. 23 31 00 - Ducts and Accessories
  - 11. 23 40 01 - Duct Cleaning
  - 12. 23 70 00 - Central Air Handling Units
  - 13. 25 50 00 - Building Automation and Control
  - 14. 25 55 00 - Variable Speed Drives
  - 15. 25 09 00 - Sequences of Operation

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. AMCA 99 (Air Movement and Control Association) - Standards Handbook.
- C. ASHRAE Handbook 2003 HVAC Applications, Chapter 47 – Sound and Vibration Control.
- D. ASHRAE Standard 90.1-2003 Energy Standard for Buildings Except Low-Rise Residential Buildings.

**1.3 SYSTEM DESCRIPTION**

- A. This section describes the specialized dedicated outside air (DOA) units which recapture both sensible and latent energy from the buildings exhaust/relief air and transfer it directly back into the buildings fresh outside intake air to conserve energy. A separate roof mounted DOA unit is provided for air handlers AHU-1 through AHU-5. Each unit is identical except for physical size and air flow capacity. As AHU-6 is a 100% outside air unit, many of the key features of a DOA are incorporated directly into the AHU-6 supply and exhaust fan cabinets.

**1.4 SUBMITTALS**

- A. Product Data:
  - 1. Provide submittal data in accordance with the general requirements of Section 20 00 00 - Mechanical General Requirements. Include the additional submittal information specific to the equipment specified by this section to include:
    - a. Manufacturer detailing dimensions, required clearances, components, shipping splits/weights, method of field assembly, and location and size of each field connection.
    - b. Certified fan-performance curves (with system operating conditions indicated) and fan-sound power ratings.
    - c. Certified coil-performance ratings (with system operating conditions indicated).

- d. Motor ratings, electrical characteristics, motor and fan accessories.
  - e. Material types, gauges and finishes.
  - f. Filters and their performance characteristics.
  - g. Dampers, including housings linkages, and operators.
  - h. Control components.
  - i. Enthalpy and desiccant rotor performance data with system operating conditions indicated.
  - j. Electrical connection details and requirements.
  - k. Airflow static pressure drop calculations for each section.
  - l. Vibration and seismic support information for internally mounted equipment in accordance with Section 13 48 00 – Vibration and Seismic Control.
- B. Substitutions:
1. Cost of design modifications as a result of proposed product substitutions shall be borne by the Contractor.
- C. Shop Drawings:
1. Provide dimensional and orientation information (plan and elevation) for the approved dedicated outside air units incorporated into the ventilation system shop drawings.
  2. Indicate actual cabinet location, sectional and overall cabinet dimensions, roof curbs, damper sizes and arrangement, access door locations, access clearances for filter, coil and fan replacement, duct connections, and electrical connection points.
  3. Coordinate roof penetrations with structural.
  4. Label overall dedicated outside air units as scheduled. Label each cabinet section as specified.
  5. Provide dedicated outside air unit cabinet/roof curb anchoring method approved by the seismic design engineer in accordance with Section 13 48 00 – Vibration and Seismic Control.
- D. Operation and Maintenance (IO&M) Manual:
1. Provide a complete copy of the manufacturer's written installation, operation and maintenance manual to include the following information:
    - a. Manufacturer's descriptive literature.
    - b. Installation instructions.
    - c. Operating instructions.
    - d. Troubleshooting guide.
    - e. Preventative maintenance requirements.
    - f. Complete parts list.
    - g. Recommended spare parts list.
  2. Neatly annotate the IO&M manual to clearly indicate information applicable to the equipment installed.
- E. Closeout Submittals:
1. Project record drawings:
    - a. Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation of the dedicated outside air units.
  2. Provide written startup report and certificate from the Manufacturer's Representative indicating that the dedicated outside air units are installed and operational in accordance with the manufacturer's written installation, operation and maintenance manual and project sequence of operations.

## 1.5 QUALITY CONTROL

- A. Labeling
1. UL or ETL Label and be constructed in accordance to UL 1995, UL795 with all features and options included in the listing, including controls (shipped loose).

- B. Manufacturer's Qualifications:
  - 1. Manufacturer shall have a minimum of ten years experience producing substantially similar equipment, and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- C. Installers' qualifications:
  - 1. Minimum three (3) years experience in the installation and start-up of dedicated outside air units.
- D. Regulatory requirements:
  - 1. Products requiring electrical connection: Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Municipality.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  - 1. Verify dedicated outside air units and associated appurtenances are delivered in original factory packaging/crating and are free from damage and corrosion.
  - 2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Department.
- B. Storage and Protection:
  - 1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

## 1.7 WARRANTY

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. Concepts and Designs, Inc. (CDI) (Basis of Design) or preapproved equal.

### 2.2 UNIT CONSTRUCTION

- A. No Through Metal (NTM) Unit Design
  - 1. Base frame construction shall be 4" thick NTM frame design for supporting the casing and its internal components such that there are no thermal breaks (thermal bridges or metal fastener connections of any kind) within the casing's thermal barrier.
  - 2. Casing wall penetrations for air inlet, air outlet and access panels shall be provided with a hard rubber thermal break between the gap of the exterior and interior panels. Casing wall and roof penetrations for air inlet and outlets shall be a finished cover plate spanning the thermal gap between the exterior and interior of the unit casing. Casing wall penetrations shall be provided with a finished cover plate both on the interior and exterior of the unit casing.
- B. Base Frame Construction (NTM)
  - 1. Units shall have a 6" structurally formed aluminum base frame suitably reinforced and braced to permit loading, shipping, unloading and rigging to the unit's installation location and general handling of the completed sections without damage to external and internal components, and misalignment of factory assembled components due to normal handling techniques.
  - 2. The base frame shall consist of an external structural frame with a separate, welded sub frame. The exterior base frame and interior sub frame shall be independent of one another, free of thermal bridges and metal fastener connections. The sub frame shall be constructed of aluminum and capable of supporting the internal loads of the unit. The

sub frame shall be supported within the external frame by hard rubber pads placed under its cross members and around its perimeter.

3. Units shall be provided with lifting lugs. If the base is full length (without section splits), the lifting lugs shall be located at the corners and shall have additional sets along the unit length. If the base is split into sections, the lifting lugs shall be located at the corners of each section.
4. The base frame assembly shall be insulated with closed cell polyurethane expandable foam insulation. The foam insulation shall have a minimum thickness of 6 inches with an R-value not less than 36. Insulation material shall conform to UL STD 94 HF1 flame spread and combustibility requirements.
5. The floor decks shall be lined with an underside sheathing of aluminum. Insulation as previously specified shall be installed between the sheathing and top wearing aluminum floor surface. The floor shall consist of 24" maximum width panels with a minimum of 4" deep aluminum (interior base frame construction) C-Channels for support. This floor shall sustain the equipment loading and normal maintenance loading for the unit.

C. Casing Construction

1. Exterior and interior wall and roof panels shall be constructed of aluminum and fabricated into self-framing seam type construction. The panels combined, caulked and sealed, shall form a thermal barrier wall casing with no additional structural supports required.
2. Wall and roof assemblies shall be insulated with closed cell polyurethane expandable foam insulation to R-24 (minimum) and conforming to UL STD 94 HF1 flame spread and combustibility requirements.
3. Panel joints caulked airtight with silicone sealant with casing leakage not to exceed 1% at 1 ½ times design total static pressure.
4. Component closures for coils, dampers and filters, shall be airtight. Closures shall be aluminum and provide solid close-off inside the unit walls. Caulked and sealed to eliminate air bypass or leakage around closures.
5. The exterior of the unit shall be mill finish aluminum and painted to weather a marine environment. Coordinate paint color with Architectural.

D. Access Door Construction

1. Access doors shall be of a NTM design including both door frame and door panel assemblies.
2. Inner and exterior access door panels shall be constructed of aluminum with extruded aluminum reinforcing blocks at latch locations and an insulated core similar to the wall and roof sections. Observation windows for each section of the unit containing: a fan, filter, or operating wheel shall be provided. The door exteriors shall be painted to match the cabinet.
3. The doors shall be installed to swing to seal/seat with fan static pressure (outward on suction side, inward on discharge side).
4. The doors shall include heavy-duty stainless steel hinges and heavy-duty keyed latches, operable from both the exterior and interior of the unit.
5. Door frames shall be extruded aluminum with press fitted, field replaceable Santoprene® or equal airtight gaskets.

### 2.3 SHIPPING SPLITS

- A. Shipping splits, if required, shall be constructed using a bolted mating angle design on unit interior walls, roofs, and bases. At standing roof seams (if applicable), provide field installed "C" hat channel to form a rain tight seal. Caulk split joints airtight with 100% Pure RTV silicone sealant.

## 2.4 OUTSIDE AIR INTAKE SECTION AND HOODS

- A. Hoods: Ridge, reinforced, aluminum construction, sized for the scheduled outside air intake and relief rates (CFM) at a maximum air velocity of 500 FPM. Painted to match unit cabinet. Provide gutters for water run-off.
- B. Bird Screen: Aluminum bird screen constructed from "punched aluminum. "Chicken wire" is not acceptable.
- C. Moisture Eliminator: Provide moisture eliminator with holding bracket designed for simple field installation/removal with condensation gutter and indirect drain to roof.
  - 1. One (1) inch thick, Type 304 stainless steel construction with rigid stainless steel frame.
  - 2. Maximum air pressure drop: 0.1 inWC at 500 FPM.
  - 3. Performance: 99% water droplet removal at 500 FPM.
  - 4. Manufacturer: Mistop (a division of Acme Mfg. Corp.) or pre-approved equal.
- D. Dampers: Low leakage dampers shall meet the following minimum construction standards.
  - 1. Extruded aluminum hat channel frames and air foil type blades.
  - 2. Hexagonal axials (for positive locking blade/linkage connections). Non-corrosive, molded synthetic bearings. Linkages concealed within frame.
  - 3. Inflatable pocket type edge seals (fan air pressure assists in blade to blade seal off). Field replaceable.
  - 4. Tested in accordance with AMCA 511 for air performance and leakage.
  - 5. Manufacturer: Ruskin, Model CD-50 (Basis of design) or pre-approved equal.
- E. Damper Actuators:
  - 1. General purpose actuator. Externally (outside air stream) or internally (jack shaft) mounted and direct coupled to shaft axles.
  - 2. Two position or modulating position (as required), spring return, 120 VAC power.
  - 3. Direct coupled mounting with self centering shaft clamping adapter.
  - 4. Rotational stroke mechanically limited to 5 degree increment adjustment.
  - 5. Total rotation stroke of  $95 \pm 3$  degrees for tight closure. Spring return (clockwise or counterclockwise) to a fail-safe position on loss of power.
  - 6. Manual repositioning capability on loss of power.
  - 7. Manufacturer: Siemens (Basis of design), Belimo, Honeywell or pre-approved equal.

## 2.5 PRE-FILTERS/REACTIVATION FILTER

- A. Manufacturers:
  - 1. Camfil Farr 30/30 (MERV8) (Basis of Design).
  - 2. American Air Filter.
  - 3. Pre-approved equal.
- B. Provide disposable, pleated dry media filters having an average efficiency of 25 percent to 30 percent when tested in accordance with ASHRAE 52.1-1992 with an average arrestance of 90 percent to 92 percent.
- C. Complete filter UL listed as Class 2 air filter.
- D. Filter shall be constructed from pleated media supported and bonded to welded wire grid within a rigid beverage board frame. Media shall be non-woven, reinforced cotton and synthetic fabric. Media shall provide not less than 4.6 square feet of filter area for each square foot of face area. Media and frame shall be bonded to prevent air leakage.
- E. Design of filter bank shall be based on an airflow rate of not more than 500 CFM per square foot of gross face area unless otherwise indicated. Initial static pressure loss shall not exceed 0.23 inches water column at 500 feet per minute face velocity. Filter shall be designed to operate at up to 2 inch water column, if required.
- F. Preferred filter sizes are 24 by 24 by 2 inches and 24 by 12 by 2 inches. Filter banks for dedicated outside air units shall be designed to use the minimum number of readily available standard filter sizes.

## 2.6 INTERMEDIATE FILTERS

- A. Manufacturers:
  - 1. Camfil/Farr, E-Series RIGA-FLO (MERV 14) (Basis of Design)
  - 2. American Air Filter.
  - 3. Pre-approved equal.
- B. Provide high performance, preformed, deep pleated, rigid disposable type dry media filters having an average efficiency of 80 to 85 percent when tested in accordance with ASHRAE 52.1-1992 and an average arrestance of not less than 97.5 percent (standard test) and 12 percent (0.3 micron duct).
- C. Complete filter shall be UL listed as a Class 2 air filter
- D. Non-steel construction. Moisture-resistant, rustproof housing, Non-woven polypropylene micro-fiber filter media with stiffened backing. Rigid grille and contour stabilizer supports to prevent oscillation and sagging of media.
- E. Size filter bank for 500 FPM airflow velocity. Initial static pressure not to exceed 0.41 inches water column at 500 feet per minute face velocity. Filter shall be designed to operate at up to 1.5 inches water column (manufacturer's recommended final resistance).
- F. Preferred filter sizes are 24 by 24 by 12 inches deep and 24 by 12 by 12 inches deep. Filter banks shall be designed to use the minimum number of readily available standard filter sizes.

## 2.7 ENERGY RECOVERY SYSTEM

- A. Provide rotary air-to-air heat exchanger wheel with the performances and efficiencies as scheduled. Flame-spread rating: 25 or less. Smoke-developed rating: 50 or less. Performance certified by AHRI Standard 1060.
- B. Rotor
  - 1. Constructed of smooth and corrugated aluminum sheets interwoven to form a wheel, creating a large number of axial passages through which the air flows. A smooth flange attached to the outer diameters of the wheel provides a smooth surface for the peripheral seal is installed. Axial wheel passages must be capable of passing 1000-micron particles.
  - 2. The aluminum rotor surfaces shall be treated for corrosion resistance and include a low co-adsorption ion exchange resin media to adsorb and transfer humidity in the vapor phase. Coat the substrate and resin with a permeable anti-mold/mildew treatment.
  - 3. The rotor shall be capable of withstanding cleaning by vacuum cleaner, with water and detergent or with low-pressure compressed air.
  - 4. Provide rotor surfaces ground and polished smooth for long seal life and to prevent annular cross contamination between air streams.
  - 5. Provide segmented rotor construction for rotors more than 68 inches in diameter (four (4) sections). For rotors more than 114 inches in diameter, provide a minimum of six and a maximum of 8 sections.
  - 6. Support sections in place as pie segments contained by peripheral channels formed together, and to adjoining sections and to the hub such that bypassing of air around the peripheral channels will not occur. Wheel segments shall be readily removable and replaceable in the field.
- C. Rotor Cassette
  - 1. Provide a 10 gauge (minimum) steel rotor cassette with built-in purge section to provide minimum cross contamination of exhaust air.
  - 2. Include built-in purge section to limit exhaust air carry-over into the outside supply air stream to 0.04% when operated under design conditions.
  - 3. Isolate supply and exhaust air streams using adjustable seals secured to the cassettes panels and duct dividers. The seals shall consist of a double layer of neoprene wiper seals, labyrinth or brush seals. Wiper and brush seals shall be installed in contact with the wheel flange in order to minimize leakage between the supply and exhaust air systems.

Labyrinth seals shall be installed with a minimum gap between the seal and the wheel flange.

4. Provide corrosion resistant powder coating for all metal parts exposed to the air streams.
- D. Rotor Drive System
  1. Support rotor with ball bearing type hub supports and rotate rotor wheel with belt driven, factory mounted, electric drive motor with VSD speed controller.
- E. Rotation Failure Detector: Provide a factory mounted rotation detection device that communicates with the VSD speed controller and includes a relay connected to the BAS. In the event of a rotor drive system failure, send a "DOA-X Enthalpy Wheel Trouble" alarm to the BAS.

## 2.8 SUPPLY AND EXHAUST FANS

- A. Single width, single inlet, airfoil type direct drive fan wheels. Aluminum construction with stainless steel shaft.
- B. Totally enclosed, fan cooled, premium efficiency, VSD rated, 460 VAC/3 Phase. Horsepower as scheduled.
- C. Fan and motor dynamically balanced as an assembly
- D. Fan speed control:
  1. Fans equipped shall be equipped with Piezometer Ring Airflow Measuring System with differential pressure transducers installed by the fan manufacturer.
  2. VSD controllers modulate fan speed to maintain constant air flow rates (CFM) (adjustable) as measured by the air flow measuring system.
- E. Internal seismic/vibration isolation:
  1. The blower, motor, and drive assembly shall be mounted on a heavy duty steel frame support. The frame shall be mounted on spring isolators (2" minimum deflection) with seismic snubbers designed with a minimum 90 percent isolation efficiency.
  2. Provide plenum fan inlet with a minimum 6" flexible ducting, rigidly fastened to the blower and the blower inlet closure.
  3. See 13 48 00 – Vibration and Seismic Control for additional requirements.

## 2.9 REACTIVATION FAN

- A. Single width, single inlet, airfoil type direct drive fan wheels. Stainless steel construction with stainless steel shaft.
- B. Totally enclosed, fan cooled, high efficiency, 460 VAC/3 Phase. Horsepower as scheduled.
- C. Fan and motor dynamically balanced as an assembly
- D. Motor shall be completely isolated from the reactivation air stream by means of a shaft sealing plate. Shaft sealing plate suitable for water pump applications that completely seals the motor shaft.

## 2.10 ELECTRIC PRE-HEATER

- A. Heater frames and terminal boxes constructed from heavy gauge, corrosion-resistant steel. NEMA 3R terminal boxes with hinged covers. Heater power rating as scheduled.
- B. Heating elements shall be open coil, 80% nickel, 20% chromium, type A resistance wire. Coils supported by high temperature ceramic bushings staked into supporting brackets. Coils are mechanically crimped into stainless steel terminals. Connection also includes 10-32 terminal threads and stainless steel connection hardware. Internal wiring shall be properly sized, stranded copper wire with 105°C insulation.
- C. Heater outlet modulation provided with SCR type controller with analog input signal capability. Heater control shall include disconnect switch, thermal cutouts (automatic reset), airflow switch, contactors, transformer, and fuses (for heaters over 48 amps).

- D. Disconnect switches interlocked with terminal box door and provided with snap-acting "on" and "off" switch positions and manual reset thermal cutout.
- E. Automatic reset thermal cutout mounted in top flange to sense maximum temperature.
- F. Airflow switch shuts heater off if duct pressure falls below 0.07 in WC.
- G. Heavy-duty control transformers (fuses where required).

## 2.11 DESICCANT DEHUMIDIFICATION SYSTEM

- A. Desiccant Rotor
  - 1. Assembled from smooth and corrugated sheets of ceramic substrate interleaved in a winding to form the rotor creating a large number of axial passages through which the air flows. The silicate desiccant shall adsorb water molecules in the vapor phase.
  - 2. The ceramic rotor substrate shall be manufactured from a ceramic fiber matrix meeting the International Agency for Research on Cancer (IARC) standards for non-respirable fibers and provide the structural support for the desiccant.
  - 3. The substrate shall be combined with desiccant to form the dehumidifier rotor.
  - 4. The desiccant shall be self-bonding to both the ceramic substrate and itself, totally encapsulating the substrate.
  - 5. A smooth flange shall be attached to each side of the outer diameter of the wheel where the peripheral seal is installed.
  - 6. Rotor surfaces shall be ground, polished smooth and coated for long seal life.
  - 7. Rotor shall meet NFPA – 101 flame spread (FSI)/smoke ratings (SDI) of less than or equal to 25/25 respectively.
  - 8. The rotor shall be both washable and non-shedding. Rotors shall be capable of withstanding cleaning by vacuum cleaner and water and detergent.
  - 9. Rated lifetime: 87,600 hours (minimum) defined by media performance meeting >90% of original specification.
  - 10. Rotors shall be manufactured in an ISO-9001, ISO-14001 registered manufacturing facility.
  - 11. The rotor performance shall meet the dew point values of the mixed air downstream of the face and by-pass section. Bypass dampers shall be sized for full process air flow with minimal air pressure drop and positioned for full bypass when dehumidification of the outside air stream is not required.
- B. Cassette Frame
  - 1. Type 304 stainless steel construction.
- C. Drive System
  - 1. Rotor drive shall be a parallel shaft gear reducer and motor (gear motor).
  - 2. Equipped with rotation detection circuit which shuts down the dehumidifier and provides both local and remote BAS alarms if the wheel is not rotating.
- D. Seals
  - 1. Provide Teflon coated "Viton ®" rotor seals along the two adjacent openings of the rotor cassette frame and Rulon® bearing tape along the rotors perimeter surfaces to form a low friction air-tight seal, ensuring no air bypasses the rotor cassette assembly.
  - 2. Provide rotor dividing seals in contact with the face of the desiccant rotor media to seal between the process and reactivation airstreams.
  - 3. Provide RTV silicon sealant for other areas of the rotor assembly that have a potential for air bypass.
- E. Reactivation Tunnel
  - 1. Provide electric resistance coils with SCR controls for reactivation air heating.
  - 2. Provide inlet and outlet tunnels to separate the reactivation airstreams from the supply air stream utilizing double walled/insulated stainless steel duct construction. Provide outlet tunnel designed to remove condensation with an integral drainage system.

3. Include heat deflectors to eliminate scorching of the desiccant rotor ceramic fiber substrate.
  4. Manually adjusted outside air damper to control reactivation air flow rate through the reactivation tunnel system. Aluminum construction with locking quadrant lever.
- F. Reactivation Rate Controller (RRC) Microprocessor controller (integrated within main unit controller) to include:
1. Senses desiccant rotor rotation and inlet/outlet tunnel temperatures. Shuts down reactivation system in the event of an abnormal condition.
  2. Modulates reactivation system energy based on demand level.
  3. Annunciator panel with graphical display to include:
    - a. Reactivation Energy Rate Bar Graph
    - b. Power On Indicating Light
    - c. Rotation Fault Indicating Light
    - d. Process Air Flow Indicating Light
    - e. Process Fan On Indicating Light
    - f. Other Faults Indicating Light
    - g. Reactivation Air Flow Indicating Light
    - h. Reactivation Fan On Indicating Light
    - i. Call for Dehumidification Indicating Light
    - j. Low Reactivation Temperature Indicating Light
- G. Face/Bypass Dampers and Closure: Low leakage dampers shall meet the following minimum construction standards.
1. Extruded aluminum hat channel frames and air foil type blades.
  2. Hexagonal axials (for positive locking blade/linkage connections). Non-corrosive, molded synthetic bearings. Linkages concealed within frame.
  3. Inflatable pocket type edge seals (fan air pressure assists in blade to blade seal off). Field replaceable.
  4. Tested in accordance with AMCA 511 for air performance and leakage.
  5. Manufacturer: Ruskin, Model CD-50 (Basis of design) or pre-approved equal.
- H. Damper Actuators:
1. General purpose actuators. Externally (outside air stream) or internally (jack shaft) mounted and direct coupled to shaft axles.
  2. Two position or modulating position (as required), spring return, 120 VAC power.
  3. Direct coupled mounting with self centering shaft clamping adapter.
  4. Rotational stroke mechanically limited to 5 degree increment adjustment.
  5. Total rotation stroke of  $95 \pm 3$  degrees for tight closure. Spring return (clockwise or counterclockwise) to a fail-safe position on loss of power.
  6. Manual repositioning capability on loss of power.
  7. Manufacturer: Siemens (Basis of design), Belimo, Honeywell or pre-approved equal.

## 2.12 VARIABLE SPEED DRIVES

- A. See Section 25 55 00 – Variable speed Drives.

## 2.13 ELECTRICAL WIRING AND LIGHTING

- A. Provide electrical wiring in accordance with National Electric Code.
- B. Electrical wiring shall be installed in rigid aluminum conduit. Flexible conduit is permitted when rigid conduit is not applicable. When required, flexible conduit shall be UL approved, liquid tight and in lengths not to exceed 24 inches.
- C. Where unit construction is such that wiring must be disconnected for shipment, provide terminal blocks at the section points for future field wiring.
- D. Unit panel shall be provided with a terminal strip for single location connection of external control wiring.

- E. Provide one 75 watt vapor proof light fixture in each accessible section of the unit cabinet. Control lighting circuit from a 20 amp, 120 volt switch at the unit entrance door to the master control panel.

#### **2.14 CONTROLS**

- A. Provide NEMA 4X control panel enclosure supplied with a “dead-front” style disconnect switch, control transformers, microprocessor controller, fuses, terminal strip and motor starters with circuit breaker style overload protection. Fan/Blower motors shall be wired to the motor starters.
- B. The controller shall include a built-in terminal display for the display and adjustment of critical unit functions and alarms.
- C. The controller shall be capable of accepting common transmitter signals such as 0-1VDC, 0-5VDC, 0-10VDC, 0-20mA and 4-20mA.
- D. The controller shall include interface modules for connectivity to the BAS using BACnet IP protocol.
- E. Provide terminal strip connections for smoke detection, fire protection, E-Stop, or “other fault” inputs to shut down the unit.
- F. The dehumidification unit controller points shall be available to the BAS via the BACnet connection. Section 23 84 00 – Humidification Equipment for room humidity transmitter and remote set point adjustment.

#### **2.15 MARKINGS**

- A. The unit nameplate shall be permanently engraved with: unit model number, serial number, full load amps (FLA), supply voltage and filter schedule.
- B. If section splits are required matching pieces of units shipped in sections shall be marked for easy identification of adjoining sections.
- C. Proper warning labels for high voltage and moving parts shall be permanently affixed to access doors and guards.
- D. Advisory labels for filter access shall be affixed to applicable doors.
- E. Electrical connection, lifting points, air connections shall be marked.
- F. Indication of correct rotation shall be affixed to all electric motors.
- G. An electrical ladder diagram shall be permanently affixed inside of the electrical control panel. The schematic shall be specific to the project and not a generic type encompassing features or options not present on the unit. The schematic shall include the fuse replacement values and types. The ladder diagrams and schematics shall be protected with clear lamination.

#### **2.16 SPARE PARTS**

- A. Provide one set of spare parts as recommended by the manufacturer.

#### **2.17 ROOF CURBS**

- A. For roof curbs, see Section 07 72 00 Roof Accessories. See 13 48 00 Vibration and Seismic Control for additional anchoring requirements.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Planning: Dedicated outside air (DOA) unit coordination with Architectural and Structural components is critical. Roof curbs and maintenance clearances are critical and are

coordinated with internal building systems. Prepare and submit detailed shop drawings to confirm DOA locations, roof curb and roof penetration locations and seismic restraint. Do not order DOAs without approved shop drawings.

- B. Protection:
  - 1. Maintain access doors shut, dampers and duct connections covered and drain connections capped to protect components from construction dirt and debris.
  - 2. Protect air inlets with MERV 8 filters during construction.
- C. Surface Preparation:
  - 1. Provide level, properly sized and structurally designed roof curbs to support equipment.

### 3.2 INSTALLATION

- A. Install DOA units in compliance with the manufacturer's written installation instructions, approved shop drawings and the following:
  - 1. Install ductwork in accordance with Section 23 31 00 – Ducts and Accessories.
  - 2. Install Humidity sensors in Accordance with Section 23 84 00 Humidity Equipment.
  - 3. Install BAS actuators, sensors, controls and control wiring in accordance with Section 25 50 00 – Building Automation and Control.
  - 4. Connect electrical power and wiring in accordance with Divisions 26, 27 and 28.
  - 5. Seismically anchor base frame to roof curb/structure using anchor bolts appropriate for the installation in accordance with Section 13 48 00 - Vibration and Seismic Control.

### 3.3 CONSTRUCTION

- A. Interface with other Work:
  - 1. Coordinate and sequence DOA unit installation with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department.

### 3.4 REPAIR/RESTORATION

- A. Repair product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### 3.5 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Manufacturer's Field Start-up Services:
  - 1. Start-up and adjust DOAs to within tolerances as specified by the equipment manufacturer.
  - 2. Operationally test DOAs and system sequencing in accordance with the manufacturer's written installation and testing instructions and Section 25 09 00 – Sequence of Operations.
  - 3. Operationally test safety devices, make final set point adjustments and record settings.
  - 4. Submit a letter of certification and written start-up report, indicating that the DOA start-up has been completed, that the DOAs are properly adjusted and operating within the tolerances as specified by the manufacturer, and that the intent of the Sequence of Operation is fulfilled.
  - 5. Provide four (4) hours operating instruction to authorized Department's personnel.

**3.6 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down internal and external surfaces.

**3.7 SYSTEM STARTUP**

- A. Start-up and operate DOAs in accordance with the manufacturer's written installation, operation and maintenance manuals.
- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

**3.8 ADJUSTING**

- A. Test, adjust and balance DOA units in accordance with Section 23 05 93 – Testing, Adjusting and Balancing, the manufacturer's recommendations and as otherwise directed by the Department's Representative.

**END OF SECTION 23 72 13**

**SECTION 23 82 00**  
**TERMINAL HEATING AND COOLING UNITS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Cabinet unit heaters.
  - 2. Unit heaters.
  - 3. Fintube radiation.
  - 4. Radiant ceiling panels.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 29 - Hangers and Supports
  - 4. 20 05 53 - Mechanical Identification
  - 5. 20 07 00 - Mechanical Insulation
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 23 - Motors
  - 9. 25 09 00 - Sequences of Operation
  - 10. 25 50 00 - Building Automation and Control
  - 11. Divisions 26, 27 and 28 - Electrical

**1.2 REFERENCES**

- A. International Mechanical Code (IMC)
- B. Uniform Plumbing Code (UPC)
- C. NFPA 70 – National Electrical Code (NEC)

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements: Provide terminal heating units, piping, appurtenances, and controls to automatically maintain interior temperature setpoint for each area of the building.
- B. Performance Requirements: Provide performance and output shown or scheduled.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Submit product literature for items specified in Part 2 and those products required by the performance standards of this section. Literature clearly annotated to indicate specified salient features and performance criteria.
  - 2. Include the following:
    - a. Performance characteristics as scheduled.
    - b. Enclosure style, material and grille arrangement.
    - c. Dimensional data.
- C. Shop Drawings:
  - 1. For custom architectural fintube heating enclosures, provide shop drawings which include:
    - a. Custom enclosure dimensions and method of construction.
    - b. Fintube location and support method to include expansion/contraction compensation.

- c. Inlet and outlet grille model and fastening method.
  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. Samples:
  1. Provide color samples of fintube and cabinet unit heater enclosures.
  2. Colors to be selected by the Department's Representative.
- E. Quality Control/Control Submittals:
  1. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment.
    - b. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - c. Included with the manual one (1) copy of the completed start-up and operation checklist. The checklist shall include:
      - 1). Printed names and signatures of the installers.
      - 2). Documentation from Manufacturer's representative and the Department's Representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
- F. Closeout Submittals:
  1. Project Record Documents: Record actual locations of components and locations of access doors in terminal unit cabinets required for access or valves.
  2. Operation and Maintenance (IO&M) Manuals:
    - a. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
    - b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3)-years documented experience.
  2. Acceptable Installers: Minimum three (3)-years experience in the installation and start-up of Terminal Heating and Cooling Units.
- B. Pre-Installation Meetings:
  1. Coordinate installation of Terminal Heating and Cooling Units with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any terminal heating and cooling unit components.
- C. Regulatory Requirements:
  1. 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. Acceptance at Site:
  1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.

- B. Storage and Protection:
  - 1. Outside the general construction zone, store products in covered storage area protected from the elements, until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 3. Replace damaged items with same item in new condition.
- C. Extra Materials: Provide one (1) set replacement filters for cabinet unit heaters.

## 1.7 WARRANTY

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements.

## PART 2 - PRODUCTS

### 2.1 FINTUBE RADIATION

- A. Description: Radiation heating terminal units consisting of continuous finned tubing with or without metal enclosure.
- B. Heating Elements:
  - 1. Seamless copper tubing suitable for soldered fittings (as scheduled).
  - 2. Mechanically expanded, evenly spaced aluminum fins (as scheduled).
- C. Element Hangers: Elements shall be supported by sliding or rolling brackets designed to provide for unrestricted longitudinal movement and noiseless expansion. Hangers from the upper portion of the back panel which shall be of sufficient length to accommodate expansion and contraction of the element without distortion of the fins. Hangers shall be designed to support the element clear of all portions of the enclosure and shall not depend upon any frictional device for attachment. Hangers are not applicable to more than one element tier. Provide an approved expansion compensator for each 20 feet or greater of element including bare pipe connections.
- D. Enclosures: Configuration and dimensions as scheduled and to include:
  - 1. Minimum metal thickness: 14 gauge.
  - 2. Full back panel with vertical stiffeners and elements supports.
  - 3. Lower edge of enclosure braced to element supports and/or back panel.
  - 4. Concealed tongue and groove type stiffener joints between enclosure sections.
  - 5. Wall to wall enclosure or end covers as shown.
  - 6. Support cabinet rigidly to wall or on floor mounted brackets at three (3) feet on center maximum spacing.
- E. Finish: Factory applied baked enamel finish. Colors to be selected by the Department's Representative.
- F. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- G. Access Doors: For otherwise inaccessible valves, provide factory made permanently hinged access doors integral with cabinet.
- H. Rated heat output shall be determined in accordance with I-B-R procedures. Unless otherwise stated, the heat output requirements listed in the Schedule are standard catalog ratings for hot water at a tube velocity of three feet per second. Corrections for velocity and glycol solutions have been included in calculations to determine element length and flow volume.
- I. Capacity: As scheduled.
- J. Manufacturers: Sterling (Basis of Design), Modine, Rittling, Trane, Vulcan.

### 2.2 FINTUBE RADIATION (ELEVATOR SUMP)

- A. Description: Radiation heating terminal units consisting of electric heating elements with heavy gauge perforated aluminum or coated steel metal enclosure.

- B. Heating Elements:
  - 1. Electric heating elements (as scheduled).
- C. Element Hangers: Elements shall be supported by sliding or rolling brackets designed to provide for unrestricted longitudinal movement and noiseless expansion. Hangers from the upper portion of the back panel which shall be of sufficient length to accommodate expansion and contraction of the element without distortion of the fins. Hangers shall be designed to support the element clear of all portions of the enclosure and shall not depend upon any frictional device for attachment. Hangers are not applicable to more than one element tier. Provide an approved expansion compensator for each 20 feet or greater of element including bare pipe connections.
- D. Enclosures: Configuration and dimensions as scheduled and to include:
  - 1. Minimum metal thickness: 14 gauge.
  - 2. Full back panel with vertical stiffeners and elements supports.
  - 3. Fully perforated, sloped top.
  - 4. Support cabinet rigidly to wall at three (3) feet on center maximum spacing.
- E. Finish: Standard finish.
- F. Capacity: As scheduled.
- G. Manufacturers: Sterling (Basis of Design), Modine, Rittling, Trane, Vulcan.

### **2.3 FINTUBE RADIATION (CLERSTORIES AND MARQUE)**

- A. Description: Steel, one-piece, all-welded steel, double panel radiators with integral heavy gauge all-welded perforated top grille.
- B. Headers to include ½" NPT inlet, outlet and 1/8" NPT vent connections as required.
- C. Working pressure: 56 PSIG (Max).
- D. Finish: Gloss powder coat finish. Color selected by Architect.
- E. Provide ribbed pipe cover trim panels are required for a continuous uniform appearance.
- F. Capacity: As scheduled.
- G. Manufacturers: Runtal (Basis of Design) or pre-approved equal.

### **2.4 UNIT HEATERS**

- A. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- B. Casing: 0.0478 inch steel with threaded pipe connections for hanger rods.
- C. Finish: Factory applied baked enamel finish.
- D. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- E. Air Outlet: Adjustable pattern diffuser on projection models and two way louvers on horizontal throw models.
- F. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 23 21 23 – Motors.
- G. Control: Local multi-speed disconnect switch.
- H. Capacity: As scheduled.
- I. Electrical Characteristics:
  - 1. Horsepower, voltage, and phase as scheduled on the Drawings, 60 Hz.
  - 2. Refer to Divisions 26, 27 and 28.
- J. Manufacturers: Modine (Basis of Design), Rittling, Sterling, Trane, Vulcan, Dunham-Bush.

## 2.5 CABINET UNIT HEATERS

- A. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes designed for 100 psi and 220 degrees F.
- B. Cabinet: 0.0598 inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, and integral air outlet and integral air outlet and inlet grilles.
- C. Finish: Factory applied baked enamel finish. Colors to be selected by the Department's Representative.
- D. Fans: Centrifugal forward curved, double width wheels, statically and dynamically balanced, direct driven.
- E. Motor: three-speed, tap wound permanent split capacitor, with sleeve bearings, resiliently mounted. Refer to Section 23 21 23 – Motors.
- F. Control: Multiple speed switch, factory wired, located in cabinet.
- G. Filter: Easily removed, located to filter air before the coil. Permanent washable type or one (1)-inch thick glass fiber throwaway type.
- H. Mixing Dampers: Where indicated, mixing sections with dampers. Refer to Section 25 09 00 – Sequence of Operation.
- I. Capacity: As scheduled.
- J. Electrical Characteristics:
  - 1. Horsepower, voltage, and phase as scheduled on the Drawings, 60 Hz.
  - 2. Refer to Divisions 26, 27 and 28.
- K. Manufacturers: Modine (Basis of Design), Rittling, Sterling, Trane, Vulcan, Dunham-Bush.

## 2.6 HYDRONIC RADIANT CEILING PANELS

- A. Panel shall consist of extruded aluminum with copper tubing of 0.50 inch ID mechanically attached to the aluminum faceplate. Hold copper tubing in place with an integral aluminum saddle or similar metal fastener which positively secures the tube to the panel. Use of adhesives or clips is not acceptable.
- B. Not all panel hardware, mounting and attachment components and features are detailed on the Mechanical and Architectural Drawings. Provide backing, supports, moldings, hangers, cross tees, seismic restraints, hardware, and other appurtenances required for a complete and properly operating finished system. Mechanical fasteners shall not be exposed in the finish work.
- C. In addition to the Mechanical Drawings, refer to Architectural Reflected Ceiling Plans and Room Finish Schedule to determine other panel requirements.
- D. Provide finish and color selected by the Department's Representative.
- E. Cross brace entire assembly with structural members and insulate with one (1)-inch thick fiberglass insulation. Configure panels within T-bar ceiling module and run wall to wall.
- F. Heating Capacity: Panel total output rating shall be not less than 250 Btuh/SF at 190 degrees F. when tested against an average unheated surface temperature (AUST) of 70 degrees F. Data shall be certified by qualified independent test lab.

- G. Manufacturers: Sterling (Basis of Design), Airtex, or Aero Tech AX.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection:
1. Cover equipment and plug piping connections to protect components from construction dirt and debris.
- B. Preparation:
1. Prior to installation of terminal units, make sure wall construction is complete enough to correctly locate and mount units.

#### **3.2 INSTALLATION**

- A. Install terminal equipment in accordance with manufacturer's instructions.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Provide finished cabinet units with protective covers during balance of construction.
- D. Finned Tube Radiation: Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end caps where units butt against walls.
- 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. Hydronic Units:
1. Provide accessible ball type isolation valves on supply and return lines to each terminal unit to allow for unit drain down and repair.
  2. Provide low-point drain valve that allows for complete gravity drawing of terminal unit.
  3. Provide balancing valve as specified elsewhere.
  4. Provide high-point automatic air vent as specified elsewhere.
- H. Radiant Panels:
1. Provide each panel circuit with shutoff valve on supply and balancing valve on return piping.
  2. Install in accordance with the manufacturer's shop drawings.
  3. Coordinate with ceiling system and other related work.
  4. Mechanical fastenings shall not be exposed in the finished work.
  5. Install suspension system in accordance with ASTM C636.
  6. Completely cover panel with minimum of 2 inches of fibrous glass, unfaced blanket insulation.
  7. Do not connect to supply and return system until system has been flushed and cleaned.
- I. Access Doors:
1. Install such that a drain hose may be easily connected to each drain line hose bibb, allowing the applicable portion of the system to be completely drained.
- J. Install serviceable products for heating terminal units, such as balancing valves or flow control valves, to be operable and adjustable without removal of the finish cover.
- K. Provide pressure and temperature test plugs on both sides of heat transfer elements to measure the drop across runs of heat transfer elements.
- L. In systems containing glycol, provide only products specifically designed and approved for continuous operation with the glycol solution specified.

### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Coordinate and sequence installation of Terminal Heating and Cooling Units with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Department's Representative.

### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Manufacturer's Field Services:
  - 1. Verify units are installed and operational in accordance with the manufacturer's written installation instructions.
  - 2. Both the Contractor and Manufacturer's Representatives shall sign start-up and operational checklist to confirm proper unit installation and operation.

### **3.6 CLEANING**

- A. After construction is completed (including Painting), and prior to initial start-up, clean and wipe down exposed surfaces of units. Vacuum clean coils and inside of cabinets and enclosures.
- B. Touch up marred or scratched surfaces of factory finished cabinets and enclosures, using finish materials furnished by manufacturer.
- C. Clean permanent filters or install new disposable filters.

### **3.7 SYSTEM STARTUP**

- A. Start-up and operate terminal heating units in accordance with the manufacturer's written installation, operation and maintenance manuals.
- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

### **3.8 ADJUSTING**

- A. Test, adjust and balance terminal heating equipment in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

**END OF SECTION 23 82 00**

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**SECTION 23 83 00**  
**RADIANT FLOOR HEATING EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Radiant floor heating systems.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 29 - Hangers and Supports
  - 4. 20 05 53 - Mechanical Identification
  - 5. 20 07 00 - Mechanical Insulation
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 14 - HVAC Pumps
  - 9. 25 09 00 - Sequences of Operation
  - 10. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Mechanical Code.
- B. REHAU Radiant Floor Heating Systems – Technical Manual (Latest edition).
- C. WIRSBO Complete Design Assistance Manual (Latest Edition).
- D. NFPA 70 – National Electrical Code.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. This section describes specific requirements, products and methods of execution for radiant floor hydronic heating systems.
  - 2. Provide a complete, pre-engineered radiant slab heating system which automatically maintains a constant interior temperature setpoint for each radiant floor heating zone as shown.
  - 3. Not all hardware, components, and features are detailed on the drawings. Provide tubing, manifolds, fittings and hardware, isolation valves, strainers, drain valves, gauges, supports, and other appurtenances required for a complete and properly operating system.
  - 4. Coordinate slab insulation requirements with Division 7.
- B. Performance Requirements:
  - 1. Provide performance and output as shown or scheduled on drawings.
  - 2. System contains a rust inhibited water solution as specified in Section 23 21 13 – Hydronic Piping and Specialties.

**1.4 SUBMITTALS**

- A. Product Data:
  - 1. Provide manufacturers' product literature and technical instructions, clearly annotated to indicate specified salient features and performance criteria.
  - 2. Include the following:
    - a. Performance characteristics as scheduled.
    - b. Catalog data sheets for radiant floor tubing material, supports, tubing guides, spacers and associated items necessary for installation of tubing.

- c. Catalog data sheets for each pump scheduled.
  - d. Dimensional data.
  - e. Features and appurtenances being provided.
  - f. Electrical characteristics and connection requirements.
- B. Shop Drawings:
1. Refer to Section 20 00 00 – Mechanical General Requirements for general shop drawing requirements.
  2. Provide engineering design calculations that confirm heat output performance, pumping flow (gpm) requirements, pumping head requirements and supply water temperature requirements. Include circuit balancing data necessary for system start up.
  3. Provide radiant floor heating system shop drawings which indicate:
    - a. Each radiant zone location and Btuh/SF heating performance.
    - b. Zone tubing patterns, tube spacing, tubing diameters, number of circuits and circuit lengths.
    - c. Location of in-floor electrical raceways and ductwork, slab control joints and construction joints, and typical tube routing detail where piping must cross raceways or joints. Indicate these items in sufficient detail, including dimensioned locations of system components, to demonstrate complete coordination between trades.
    - d. Location of floor drains and other floor penetrations.
    - e. Manifold, circulator pump and hydronic supply and return piping locations.
    - f. System piping diagram showing piping arrangement, circulation and injection pumps, control valves, isolation valves, balance and drain valves, test fittings and vents, temperature sensors and other appurtenances.
  4. Indicate mechanical and electrical service locations and requirements.
- C. Quality Control/Control Submittals:
1. Design Data and Test Reports:
    - a. Provide design data for system components.
    - b. Provide test report for system operation.
  2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - b. Include with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      - 1). Printed names and signatures of the installers.
      - 2). Documentation from Manufacturer's representative and Department's Representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
- D. Closeout Submittals:
1. Project Record Documents:
    - a. Record actual locations of under floor system components, including tubing layout, temperature sensors, and other items as applicable.
    - b. Indicate locations of floor drains and other floor penetrations.
    - c. Indicate locations of under floor electrical raceways, ductwork, control joints and construction joints.
  2. Operation and Maintenance (IO&M) Manuals:
    - a. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
    - b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.

## 1.5 QUALITY CONTROL

- A. Qualifications:
  - 1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
  - 2. Acceptable Installers: Minimum three years experience in the installation and start-up of radiant floor heating systems.
- B. Pre-Installation Meeting: Coordinate installation of radiant floor heating system components with trades responsible for portions of this and any other related sections of the Project Manual prior to installation.
- C. Regulatory Requirements: 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Store PEX tubing in original factory packaging, out of direct sunlight, until ready for installation.
  - 3. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 4. Replace damaged items with same item in new condition.

## 1.7 WARRANTY

- A. Refer to Section 20 00 00 - Mechanical General Requirements for general mechanical warranty requirements.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Unless specified otherwise, provide products from the same manufacturer as part of a proven pre-engineered and cataloged system.
  - 1. Rehau (basis of design), Wirsbo or pre-approved equal.

### 2.2 TUBING, FITTINGS AND FASTENERS

- A. Tubing:
  - 1. High density cross-linked polyethylene (PEX) tubing with co-extruded oxygen diffusion barrier, manufactured in accordance with ASTM F877 and DIN 4726. Tubing material shall be fully cross-linked to the specified standard prior to shipment from the manufacturer.
  - 2. Tubing diameter as scheduled or as shown on the drawings. Minimum nominal inside diameter: 1/2 inch.
  - 3. Maximum operating temperature: 180 degrees F.
  - 4. Maximum operating pressure: 100 PSIG.
- B. Tube Fittings:
  - 1. Brass compression sleeve and coupling, for locations which are inaccessible after installation.
  - 2. Brass compression union nut fittings, for locations which are accessible after installation.

- C. Tubing Anchors:
  - 1. For tubing secured to wire mesh:
    - a. Molded plastic Star clips.
    - b. Nylon cable ties.
  - 2. For tubing secured to rigid insulation or wood sub-floor:
    - a. Molded plastic Screw clips.
    - b. Molded plastic C-channels with integral tubing clips to allow accurate tube spacing.

### **2.3 MANIFOLD SUPPLY AND RETURN HEADERS**

- A. Brass construction.
- B. Quarter turn ball isolation valves.
- C. Individual circuit shutoff valves and balancing valves where shown on the drawings.
- D. Air vents with isolation valves.
- E. Low point drain valves with 3/4-inch threaded hose connections and end caps.
- F. Maximum number of circuits on a single manifold: Twelve.

### **2.4 MANIFOLD ENCLOSURES**

- A. Provide a factory-built manifold enclosure (distribution cabinet) of a size appropriate for the manifold, as shown on the drawings.
  - 1. Surface mounted enclosure:
    - a. Painted steel cabinet.
    - b. Header mounting rails.
    - c. Access door.
  - 2. Fully recessed enclosure:
    - a. Adjustable floor-mounted base.
    - b. Header mounting rails.
    - c. Wall Frame.
    - d. Cover trim with access door.
- B. Field fabricated enclosure assemblies are not acceptable.

### **2.5 PUMPS**

- A. Type: System lubricated circulators, horizontal shaft, single-stage, direct connected, with resiliently mounted motor for in-line mounting.
- B. Materials:
  - 1. Pump: Cast iron, with flanged pump connections.
  - 2. Impeller: Replaceable stainless steel cartridge.
  - 3. Mechanical Seal Assembly: None.
  - 4. Dielectric flange isolation kit for connection to copper piping.
- C. Performance:
  - 1. As scheduled.
  - 2. Maximum working temperature: 230 degrees F.
  - 3. Maximum working pressure: 140 PSIG.
- D. Electrical Characteristics:
  - 1. As scheduled.
  - 2. Pump motor suitable for variable speed input from packaged controls or Building Automation System.
  - 3. 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.

## 2.6 SENSORS

- A. Temperature sensors:
  - 1. Provide air temperature sensors, slab temperature sensors, supply / return water temperature sensors and other sensors as indicated on the drawings for a complete and operational system.
  - 2. See Section 25 50 00 – Building Automation and Control for additional sensors.

## 2.7 SYSTEM CONTROLS

- A. For radiant floor systems controlled by the Building Automation System, no separate control system is required. Refer to Section 25 09 00 – Sequences of Operation.

## 2.8 VALVES

- A. For radiant floor systems controlled by the Building Automation System, motorized valves are provided under Section 25 50 00 – Building Automation and Control.
- B. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Mixing valves:
  - 1. Brass valve body, stem and slider. Replaceable plugs and seats.
  - 2. Rating: ANSI Class 125 for service at 125 PSIG and 32-250 degrees F.
  - 3. Sizing: Three PSIG maximum pressure drop at design flow rate.
  - 4. Three and four way mixing valves shall have linear flow characteristics.
  - 5. Valve actuators shall provide sufficient torque to close valves against pump shutoff head.
- D. Zone valves:
  - 1. Brass valve body and trim, rising stem, renewable composition disc.
  - 2. Rating: ANSI Class 125 for service at 125 PSIG and 32-250 degrees F.
  - 3. Sizing: Three PSIG maximum pressure drop at design flow rate.
  - 4. Two-way valves shall have equal percentage characteristics.
  - 5. Valve actuators shall provide sufficient torque to close valves against pump shutoff head.
  - 6. Two-way valves shall fail to a Normally Open position, unless otherwise indicated.
- E. Balancing valves:
  - 1. Manufacturers: Bell & Gossett, Taco.
  - 2. Calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device.
- F. Isolation valves: Ball valve, unitized type, bronze body and ball, TFE seats.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection: Cover equipment and plug piping connections to protect components from construction dirt and debris.
- B. Preparation:
  - 1. Verify that slab/ceiling (under floor) insulation, vapor barrier, reinforcing steel and other structural items are complete and ready for tubing installation.
  - 2. Verify locations of slab control, construction and expansion joints.
  - 3. Verify locations of floor penetrations, ventilation floor outlets, underground electrical trenches, structural elements and other items that may affect tubing installation.
  - 4. Verify that appropriate electrical connections are available, with the proper voltage and phase characteristics.
  - 5. Coordinate timing of work so that radiant floor tubing installation does not interfere with the work of other trades. Minimize construction activity in the area to prevent damage to tubing and other system components.

### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions. Where possible, use manufacturer's specialty tools.
- B. Refer to structural drawings for slab construction details. Tubing attachment method and frequency in accordance with manufacturer's recommendations.
- C. Where tubing crosses slab expansion, control or construction joints, route piping under joints or provide a sleeve over tubing extending 10 inches minimum beyond the joint. Sleeve material as specified in the manufacturer's installation guide.
- D. Where tubing exits the slab, provide a sleeve over tubing extending 10 inches minimum into the floor and above the floor. Sleeve material as specified in the manufacturer's installation guide.
- E. Lay out supply piping, pumps, manifolds and other components in a neat and logical fashion. Verify that components are accessible for servicing, adjustment and removal.
- F. Install drain valves such that a drain hose may be easily connected, allowing that portion of the system to be completely drained.
- G. Embed metal conduit to house slab temperature sensor in each concrete slab radiant heating zone. Extend conduit and bend up into applicable radiant heating manifold cabinet alongside heating tubing loops. Extend conduit approximately 6 inches above finished floor. Install slab temperature sensor/wire leads at the conduit termination point under the slab using a "fish tape." Once the sensor is in place, cut the fish tape and loop the end. Fish tap to remain in place to allow for future sensor removal/replacement. Tag the fish tap loop with a plastic tag labeled "Slab Temperature Sensor."

### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Coordinate and sequence installation of radiant floor heating system components with trades responsible for portions of this and other related sections of the project.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Department.

### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Flush and purge piping and manifold in accordance with manufacturer's installation guide. Verify that debris and air has been removed from floor circuits, manifold headers and supply piping.
- C. Pressure Testing:
  - 1. Prior to pouring the slab, perform a water pressure test as recommended by the manufacturer. Air testing is not acceptable. Pressurize with water for the length of time specified. If the maximum pressure drop is exceeded, repair leaks and re-test.
  - 2. Pressure gauges used for testing must show pressure increments of 1 PSIG and be located at or near the lowest point in the system.
  - 3. Comply with Code requirements during pressure testing. Where required, pressure tests should be witnessed by the Authority Having Jurisdiction.

4. Maintain operating system pressure during slab installation.
5. Complete the manufacturer's inspection and test reports showing acceptable performance and submit with warranty and IO&M documentation. Include the following:
  - a. Manufacturer's Project Start-up and Site Inspection Report.
  - b. Documentation demonstrating compliance with the Technical Information Manual.
  - c. Other documentation as required.
- D. Manufacturer's Field Services:
  1. Verify system is installed and operational in accordance with the manufacturer's written installation instructions.
  2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper system installation and operation.

### **3.6 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external system components and inside manifold cabinet.

### **3.7 ADJUSTING**

- A. Test, adjust and balance radiant floor heating system in accordance with Section 23 05 93 - Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

### **3.8 DEMONSTRATION & START-UP**

- A. Start-up and operate radiant floor heating systems in accordance with the manufacturer's written installation and operation manual checklist. Allow sufficient slab curing time before startup.
- B. During initial start up, bring slab up to temperature slowly in order to minimize the possibility of thermal shock.
- C. Demonstrate proper system operation using the building automation system.
- D. Document start-up and operational checks using the checklist and submit in accordance with submittal requirements.

**END OF SECTION 23 83 00**

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**SECTION 23 83 01**  
**SNOW MELTING EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Radiant snow melting systems.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 29 - Hangers and Supports
  - 4. 20 05 53 - Mechanical Identification
  - 5. 20 07 00 - Mechanical Insulation
  - 6. 23 05 93 - Testing, Adjusting and Balancing
  - 7. 23 21 13 - Hydronic Piping and Specialties
  - 8. 23 21 14 - HVAC Pumps
  - 9. 25 09 00 - Sequences of Operation
  - 10. 25 50 00 - Building Automation and Control

**1.2 REFERENCES**

- A. International Mechanical Code (IMC).
- B. NFPA 70 – National Electrical Code.
- C. REHAU Radiant Floor Heating Systems – Technical Manual (Latest edition).
- D. WIRSBO Complete Design Assistance Manual (Latest Edition).
- E. ASTM F876 – Standard Specification for Cross-linked Polyethylene (PEX) Tubing.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements: Provide a complete, pre-engineered, automatic radiant snow melting system to serve the parking garage entry driveway as defined by the Contract Drawings. Drawings are partially diagrammatic and do not show all hardware, components, and features. Provide tubing, manifolds, fittings and hardware, valving, strainers, drains, vents, gauges, sensors, supports, and other appurtenances required for a complete and properly operating system. When possible, provide from the same manufacturer.
- B. See Snow-Melt Manifold Schedule for zone design parameters. Additional design parameters as follows:
  - 1. Driveway slab Construction: See Civil.
  - 2. Outdoor Snow-melt temperature: 0 Degrees F.
  - 3. Wind speed: 10 MPH.
  - 4. Slab surface idle temperature: 38 Degrees F.
- C. CAUTION! Do not operate snow-melt system in an uncontrolled manner! Overheating the radiant tubing (140 degrees F. or greater) will cause system damage. Should this occur, replace tubing, sand and slab system at no additional cost to the Department's Representative..

**1.4 SUBMITTALS**

- A. Product Data:
  - 1. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
  - 2. Provide manufacturers' product literature for each system product.

3. Provide a complete copy of the technical design guide and installation instructions to be used. Clearly annotate this information to indicate installation method to be used.
- B. Shop Drawings:
1. Refer to Section 20 00 00 – Mechanical General Requirements for general shop drawing requirements.
  2. Provide engineering design calculations that confirm Performance Requirements and Design Parameters as listed. Submit calculation using copies of forms provided with the approved design manual.
  3. Provide radiant snow-melt system shop drawings which indicate:
    - a. The intended boundaries of the snow-melt system.
    - b. Number/label each loop per manifold worksheet.
    - c. Each snow melt zone/circuit location and BTUH/SF thermal performance.
    - d. Location of in-slab precipitation sensor and conduit run.
    - e. Slab control joint and construction joint locations with typical tube routing detail where piping must cross joints.
    - f. Manifold, circulator pump, expansion tank, make-up system locations.
    - g. System piping diagram showing piping arrangement, circulation pump, control valves, isolation valves, balance and drain valves, test fittings and vents, temperature sensors and other appurtenances.
  4. Indicate mechanical and electrical service locations.
- C. Quality Control/Control Submittals:
1. Design Data and Test Reports: Provide copy of certified pressure test report.
  2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide copy of completed start-up and operation checklist, including:
      - 1). Printed names and signatures of the installers.
      - 2). Documentation from Manufacturer's representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
- D. Closeout Submittals:
1. Project Record Documents:
    - a. Record actual locations of under slab system components, including tubing layout, precipitation sensor, and other items as applicable. Indicate actual locations of control and construction joints.
  2. Operation and Maintenance (IO&M) Manuals:
    - a. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.
    - b. Provide copies of approved submittal information for inclusion within the project IO&M Manual. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, parts listings, and spare parts list.
  3. Warranty:
    - a. Submit necessary documentation to the Manufacturer's Representative to validate manufacturer's warranty.
    - b. Provide one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative to the Department's Representative.

## 1.5 QUALITY CONTROL

- A. Qualifications:
1. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
  2. Acceptable Installers: Minimum three years experience in the installation and start-up of radiant snow melting systems.

- B. Pre-Installation Meeting: Coordinate installation of radiant floor heating system components with trades responsible for portions of this and any other related sections of the Project Manual prior to installation.
- C. Regulatory Requirements:
  - 1. 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.
  - 2. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.
  - 2. Store PEX tubing in original factory packaging, out of direct sunlight, until ready for installation.
  - 3. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
  - 4. Replace damaged items with same item in new condition.

## **1.7 WARRANTY**

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Unless specified otherwise, provide products from the same manufacturer as part of a proven pre-engineered and cataloged system.
  - 1. Wirsbo.
  - 2. Rehau.
  - 3. Watts Radiant

### **2.2 TUBING, FITTINGS AND FASTENERS**

- A. Tubing:
  - 1. High density cross-linked polyethylene (PEX) tubing with co-extruded oxygen diffusion barrier, manufactured in accordance with ASTM F877 and DIN 4726. Tubing material shall be fully cross-linked to the specified standard prior to shipment from the manufacturer.
  - 2. Snow Melt Tubing: 5/8 inch I.D., 3/4 inch O.D.
  - 3. Transfer Pipe Tubing: 2 inch I.D., 2-1/8 inch O.D
  - 4. Maximum operating temperature: 180 degrees F.
  - 5. Maximum operating pressure: 100 PSIG.
- B. Tube Fittings:
  - 1. Brass compression sleeve and coupling, for locations which are inaccessible after installation.
  - 2. Brass compression union nut fittings, for locations which are accessible after installation.
- C. Tubing Anchors (For tubing secured to rebar or wire mesh):
  - 1. Molded plastic Star clips.
  - 2. Nylon cable ties.

### 2.3 PRE-INSULATED PIPE

- A. Outer Shell Casing
  - 1. HDPE Extra High Molecular Weight (EHMW) Pipe (PE3408).
  - 2. Dimensions: 12.58 I. D., 12.90 inch O.D.
  - 3. Smooth jacket wall
- B. Inner Shell Casing
  - 1. HDPE Extra High Molecular Weight (EHMW) Pipe (PE3408).
  - 2. Dimensions: 6 inch (nominal), Class 100, SDR 17.
  - 3. Smooth jacket wall
- C. Interstitial Insulation
  - 1. Polyurethane Pour Foam.
  - 2. Density: 3-4 lb/ft<sup>3</sup>.
  - 3. R-Value: 6.9 Hr-ft<sup>2</sup>/BTU per inch.
  - 4. Service Temperature: -60 to 220 Degrees F.
  - 5. Manufacturer: DOW - 2.4 HFC 245fa.
- D. Fittings and Joints
  - 1. Two piece molded half shell polyurethane pour foam insulation fittings with 80 mil thickness sprayed poly shield coating on both inner and outer surfaces.
  - 2. Coating Manufacturer: Specialty Products, Inc, Model: Polyshield SS-100.
- E. Joint Sealant
  - 1. Twelve (12) inch wide shrink sleeves
  - 2. Manufacturer: CANUSA, Model: CanusaWrap.
- F. Fabricator
  - 1. Arctic Insulation and Manufacturing.
  - 2. Pre-approved equal.

### 2.4 MANIFOLD SUPPLY AND RETURN HEADERS

- A. Brass construction.
- B. Quarter turn ball isolation valves.
- C. Individual circuit shutoff valves and balancing valves where shown on the drawings.
- D. Air vents with isolation valves.
- E. Low point drain valves with 3/4-inch threaded hose connections and end caps.
- F. Maximum number of circuits on a single manifold: Eight (8).

### 2.5 VALVES

- A. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Mixing valves:
  - 1. Brass valve body, stem and slider. Replaceable plugs and seats.
  - 2. Rating: ANSI Class 125 for service at 125 PSIG and 32-250 degrees F.
  - 3. Sizing: Three PSIG maximum pressure drop at design flow rate.
  - 4. Three and four way mixing valves shall have linear flow characteristics.
  - 5. Valve actuators shall provide sufficient torque to close valves against pump shutoff head.
- C. Balancing valves:
  - 1. Manufacturers:
    - a. Bell & Gossett.
    - b. Taco.
  - 2. Calibrated plug or ball valve type balancing valves with self-sealing quick connect pressure taps, scale and locking device.

- D. Isolation valves:
  - 1. Ball valve, unitized type, bronze body and ball, TFE seats.

## **2.6 MANIFOLD ENCLOSURES**

- A. Provide concrete pre-formed vaults with diamond plate access lids at the locations indicated on Civil site plans. See Civil drawings and Section 03 46 00 Precast Wheel Stops and Sanitary Perimeter.

## **2.7 PUMPS**

- A. See Section 23 21 14 HVAC Pumps.

## **2.8 HEAT EXCHANGERS**

- A. See Section 23 21 13 Hydronic Piping and Specialties.

## **2.9 EXPANSION TANKS**

- A. See Section 23 21 13 Hydronic Piping and Specialties.

## **2.10 GLYCOL MAKE-UP SYSTEM**

- A. Manufacturers:
  - 1. Wessels Company (Basis of Design).
  - 2. Axiom Industries Ltd.
  - 3. Approved equal.
- B. Pre-engineered, pre-packaged, stand-alone glycol make-up system with single point electrical connection.
- C. Performance characteristics, size and model as scheduled.
- D. Salient features to include:
  - 1. Cross-linked high-density polyethylene tank with lid, strainer and shut-off valve.
  - 2. Painted steel tank/make-up system support frame.
  - 3. Make-up pump with magnetic starter.
  - 4. Pressure tank with pressure control.
  - 5. Priming valve.
  - 6. Pressure reducing valve.
  - 7. Shut-off valve.
  - 8. Pressure gauge.
  - 9. Pump cut-off alarm: Stops make-up pump and provides visual and audible alarms on excessive system pressure or low tank level.
  - 10. Auxiliary dry contacts for connection to BAS system.

## **2.11 GLYCOL SOLUTION**

- A. Fifty percent Dowfrost inhibited propylene glycol solution, suitable for operating temperatures from minus 40 degrees F to 250 degrees F.
- B. Fill glycol make-up tank to half capacity when clean glycol solution when testing and final check out has been completed.

## **2.12 SENSORS**

- A. Temperature sensors:
  - 1. Provide air temperature sensors, slab temperature sensors, supply / return water temperature sensors and other sensors as indicated on the drawings for a complete and operational system.
  - 2. See Section 25 50 00 – Building Automation and Control for monitoring requirements.

### 2.13 SYSTEM CONTROLS

- A. Manufacturers:
  - 1. Rehau.
  - 2. Wirsbo.
  - 3. Tekmar.
  - 4. Approved equal.
- B. Provide a pre-packaged electronic control system specifically designed for snow melt systems to provide fully automatically control of the snow-melt system in accordance with the Sequence of Operation.
- C. The snowmelt system may be controlled using the building automation system in lieu of a pre-packaged electronic control system assuming the BAS can be programmed provide similar features and control options.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection:
  - 1. Cover equipment and plug piping connections to protect components from construction dirt and debris.
- B. Preparation:
  - 1. Verify that slab insulation, reinforcing steel or wire mesh and other structural items are complete and ready for tubing installation.
  - 2. Verify locations of slab control, construction and expansion joints.
  - 3. Verify locations of underground electrical trenches, structural elements (flag poles, bollards, canopy supports, etc.) and other items that may affect tubing installation.
  - 4. Coordinate timing of work such that radiant tubing installation does not interfere with the work of other trades. Minimize construction activity in the area to prevent damage to tubing and other system components.
  - 5. Verify that appropriate electrical connections are available, with the proper voltage and phase characteristics.

### 3.2 INSTALLATION

- A. Install snow-melt system in accordance with manufacturer's written instructions using specialty tools supplied by the manufacturer when required.
- B. Refer to civil drawings for slab and remote vault construction details.
- C. Where tubing crosses sidewalk slab expansion, control or construction joints, route piping under joints or sleeve tubing extending 10 inches minimum beyond both side of the joint. Sleeve material as specified in the manufacturer's installation guide.
- D. Sleeve tubing penetrations through building slab floor, building foundation wall and vault walls. Coordinate penetration sizes and locations with structural.
- E. Provide pre-insulated pipe from Fan Room 319 floor penetration (terminate 6" above finished floor), through vertical chase, building foundation wall and to each of three (3) separate and remote snow-melt manifold vaults. Terminate pipe six (6) inches inside each vault penetration. Provide sealed ELL90 and TEE fittings and terminations as required. See drawing M516 for routing. Provide sleeves at floor (sealed water tight), foundation and vault penetrations. Coordinate pre-insulated pipe burial with Civil.
- F. Lay out supply piping, pumps, manifolds and other components in a neat and logical fashion. Verify that components are accessible for servicing, adjustment and removal.
- G. Install three-way glycol mixing valve such that it fails to the "no heat" position (i.e. bypasses heat exchanger) on loss of power to prevent over heating of radiant tubing in access of 140

degrees F. Overheating tubing will cause sand bed to fuse to tubing, reducing heat transfer capability the therefore, system performance.

### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  - 1. Coordinate and sequence installation of radiant snow-melt system components with trades responsible for portions of this and other related sections of the project.
  - 2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Department's Representative.

### **3.4 SEQUENCE OF OPERATION**

- A. Control snowmelt system utilizing manufacturer's packaged control system or building automation system.
- B. System startup:
  - 1. Below Warm Weather Cutoff setpoint 38 degrees F (adjustable), start snow-melt pumps.
  - 2. Modulate applicable three-way control valves to maintain idle setpoint temperature of 25 degrees F (adjustable).
  - 3. On detection of precipitation initiate "Melt Cycle." Modulate three-way valves to control slab temperature to Warm Weather Cutoff setpoint 38 degrees F (adjustable).
  - 4. Maintain Warm Weather Cutoff setpoint until no moisture is present or elapsed timer runtime has elapsed.
  - 5. Generate alarm if system is unable to achieve Warm Weather Cutoff setpoint in 24 hours.
  - 6. Monitor run and alarm status from BAS system.

### **3.5 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Do not operate snow-melt system in an uncontrolled manner! Overheating the radiant tubing (140 degrees F. or greater) will cause tubing damage. Should this occur, replace tubing and slab system at no additional cost to the Department's Representative.
- C. Substitute replacement parts from other manufacturers are not acceptable.

### **3.6 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Flush and purge piping and manifolds in accordance with manufacturer's installation guide. Verify that debris and air has been removed from slab circuits, manifold headers and supply piping.
- C. Pressure Testing:
  - 1. Prior to pouring sidewalk slabs and sealing pre-insulated pipe joints, perform a water pressure test as recommended by the manufacturer. An air testing is not acceptable. Pressurize system with water for the length of time specified. If the maximum pressure drop is exceeded, repair leaks and re-test.
  - 2. Pressure gauges used for testing must show pressure increments of 1 PSIG and be located at or near the lowest point in the system.
  - 3. Comply with Local codes during pressure testing. Where required, pressure tests should be witnessed by the Municipality.
  - 4. Maintain operating system pressure during slab installation.

5. Complete the manufacturer's inspection and test reports (supplied with IO&M manual) documenting acceptable performance and submit with warranty and IO&M documentation. Include the following:
  - a. Manufacturer's Project Start-up and Site Inspection Report.
  - b. Documentation demonstrating compliance with the Technical Information Manual.
  - c. Other documentation as required.
- D. Manufacturer's Field Services:
  1. Verify system is installed and operational in accordance with the manufacturer's written installation instructions.
  2. Both the Contractor and Manufacturer's Representative(s) shall sign start-up and operational checklist to confirm proper system installation and operation.

### **3.7 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external system components and inside manifold cabinet. Remove construction debris from inside remote vaults.

### **3.8 SYSTEM STARTUP**

- A. Start-up and operate snow-melt system in accordance with the manufacturer's written installation, operation and maintenance manuals. Allow sufficient slab curing time before startup.
- B. During initial start up, bring slab up to temperature slowly in order to minimize the possibility of thermal shock.
- C. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.

### **3.9 ADJUSTING**

- A. Test, adjust and balance air handling equipment in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.

**END OF SECTION 23 83 01**

**SECTION 23 84 00**  
**HUMIDIFICATION EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Packaged, electric, humidification systems for use with variable air volume and constant volume Central Air Handling Units.
  - 2. Packaged, microprocessor based, programmable, open protocol, humidification system specific controllers.
  - 3. Central air handling unit mounted steam dispersion panels.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 13 48 00 - Vibration and Seismic Control
  - 3. 20 00 00 - Mechanical General Requirements
  - 4. 20 05 29 - Hangers and Supports
  - 5. 20 05 53 - Mechanical Identification
  - 6. 20 07 00 - Mechanical Insulation
  - 7. 22 11 00 - Domestic Water Piping and Specialties
  - 8. 22 14 00 - Sanitary Waste and Vent Piping
  - 9. 23 05 93 - Testing, Adjusting and Balancing
  - 10. 23 21 23 - Motors
  - 11. 23 70 00 - Central Air Handling Units
  - 12. 25 09 00 - Sequences of Operation
  - 13. 25 50 00 - Building Automation and Control
  - 14. Divisions 26, 27 and 28 - Electrical

**1.2 REFERENCES**

- A. International Mechanical Code.
- B. Uniform Plumbing Code.
- C. ASHRAE Handbook 2008 HVAC Systems and Equipment, Chapter 20 – Humidifiers.
- D. ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
  - 1. Provide packaged, electric humidification systems to automatically maintain constant interior relative humidity levels for each centrally ventilated area of the building.
  - 2. Include additional sensing and automatic control to prevent:
    - a. Internal supply duct condensation for variable air volume ventilation applications.
    - b. Window condensation.
- B. Performance Requirements:
  - 1. Maintain relative humidity ranges in accordance with Section 23 70 00 – Central Air Handling Units design parameters.
  - 2. Automatically lower humidity set point to prevent condensation on interior window surfaces.

**1.4 SUBMITTALS**

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.

- B. Product Data:
  - 1. Provide manufacturers' product literature, clearly annotated to indicate specified salient features and performance criteria for each product specified.
- C. Shop Drawings: Provide scaled shop drawings which incorporates the following installation information:
  - 1. Humidifier locations with housekeeping pads and dimensioned access clearances.
  - 2. Exhaust vent assembly.
  - 3. Make-up water piping connections.
  - 4. Humidifier condensate drain piping and indirect drain location(s).
  - 5. Tempering device location(s).
  - 6. Packaged controller(s) location(s).
  - 7. Steam dispersion panel location(s).
  - 8. Steam supply piping/hose routing from humidifier(s) to dispersion panel(s). Indicate slope ratio and slope direction.
  - 9. Steam dispersion panel condensate drain piping.
- D. Quality Control/Control Submittals:
  - 1. Design Data, Test Reports: Provide manufacturer's test report which documents 100 percent absorption distance for installed steam dispersion panel(s).
  - 2. Certificates, Manufacturer's Instructions, and Manufacturer's Field Reports:
    - a. Provide a complete manufacturer's written installation, operation and maintenance manual for each type of installed equipment. Clearly annotate the manual to indicate applicable information for the specific equipment model(s) installed.
    - b. Included with the manual one copy of the completed start-up and operation checklist. The checklist shall include:
      - 1). Printed names and signatures of the installers.
      - 2). Documentation from Manufacturer's representative and the Department's Representative that the equipment has been properly installed and is fully operational, thus validating the equipment warranty.
    - c. Include with the checklist a list of applicable programmable control setpoints with their current programmed settings.
- E. Operation and Maintenance (IO&M) Manuals:
  - 1. Provide copies of approved submittal information for inclusion within the project IO&M Manual.
  - 2. Refer to Section 20 00 00 – Mechanical General Requirements, for IO&M Manual formatting requirements and number of copies required.

## **1.5 QUALITY CONTROL**

- A. Qualifications:
  - 1. Acceptable Installers: Minimum three years experience in the installation and start-up of natural gas fired boilers.
- B. Pre-Installation Meetings:
  - 1. Fully coordinate installation of humidification system components with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any humidification system components.
- C. Regulatory Requirements:
  - 1. 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. Acceptance at Site:
  - 1. Verify that products are delivered in original factory packaging and are free from damage and corrosion.

- B. Storage and Protection:
  - 1. Store products in covered storage area protected from the elements, outside the general construction zone until installed.

## 1.7 WARRANTY

- A. Provide warranty in accordance with Section 20 00 00 – General Mechanical Requirements.
- B. Submit required documentation to the Manufacturer's Representative to validate manufacturer's two-year warranty. Obtain written confirmation of receipt.
- C. Provide the Department's Representative with one copy of all required warranty documentation with written confirmation of receipt from the Manufacturer's Representative.

## PART 2 - PRODUCTS

### 2.1 HUMIDIFICATION UNIT

- A. Performance characteristics as scheduled.
- B. Designed specifically for use with reverse osmosis make-up water.
- C. Welded 14 gauge 316 stainless steel tank with easily removable (no tools required), gasketed, stainless steel tank cover and accessible low point cleanout.
- D. Low watt density Incoloy-sheathed electric heating elements.
- E. Terminal strip for single location electrical connections.
- F. Evaporating chamber temperature sensor.
- G. Over temperature thermostat.
- H. Water level float valve with low water cutoff switch.
- I. Overflow port.
- J. Automatic Drain assembly.
- K. Listed NEMA 12 control cabinet with hinged door with interlock switch and lock.
- L. Floor mounting stand.
- M. Manufacturer: Dri-Steem Humidifier Company VLC Series or pre-approved equal.

### 2.2 HUMIDIFICATION MANAGEMENT SYSTEM

- A. Micro-processor based, open protocol packaged controller.
  - 1. Web-enabled
  - 2. BACNet
- B. UL approved mounting cabinet.
- C. Alphanumeric key pad with digital display.
- D. Control Features:
  - 1. Four position mode switch (Auto, Standby, Drain, Test).
  - 2. Start-up initializing and self-diagnostics.
  - 3. Complete positive water level control.
  - 4. Full modulation steam output control (0 – 100 percent).
  - 5. Automatic, adjustable drain/flush control.
  - 6. End of season automatic drain.
  - 7. Freeze protection option.
- E. Variable air volume (VAV) control package option.
- F. Cold snap offset option.
- G. Provide connection to Building Automation System for remote monitoring, setpoint adjustment and control. Include necessary hardware and software for control connectivity.

- H. Manufacturer:
  - 1. Dri-Steam Humidifier Company, Model Vapor-logic4.
  - 2. Pre-approved equal.

### 2.3 STEAM DISPERSION PANELS

- A. Manufacturer:
  - 1. Dri-Steam Humidifier Company, Ultra-Sorb Series.
  - 2. No substitutions.
- B. Construction:
  - 1. Stainless steel supply header, condensate header and dispersion tubes.
  - 2. Flange type supply header connection. Threaded condensate drain connection.
  - 3. Galvanized steel casing with mounting channel for installation within central air handler casing.
  - 4. Blanked-off base area below dispersion panel to accommodate condensate drain piping and P-trap.
- C. Dispersion panel sizing as scheduled.

### 2.4 REMOTE SENSORS

- A. Duct Mounted Relative Humidity and Temperature Sensors (VAV control package option only):
  - 1. Manufacturers:
    - a. Siemens, Part Number 538-894.
    - b. Approved equal.
  - 2. Two (2) percent accuracy.
  - 3. Power module.
- B. Room Relative Humidity and Temperature Sensors:
  - 1. Manufacturers:
    - a. Siemens, Part Number 544-822.
    - b. Approved equal.
  - 2. Two (2) percent accuracy.
  - 3. LCD Display.
  - 4. Temperature setpoint adjustment, override button and operating mode indicator.
  - 5. Calibration jack.
- C. Differential Static Airflow Switch:
  - 1. Manufacturers:
    - a. Siemens, Part Number 141-0518.
    - b. Approved equal.
  - 2. One (1) inch to twelve (12) inch field adjustable setpoint range.
  - 3. Automatic reset switch.
  - 4. Static pressure sensing kit.
- D. Indoor window glass temperature sensor (cold snap offset option only):
  - 1. Manufacturers:
  - 2. Contract Instruments, Model T184-1-SP.
  - 3. Approved equal.
  - 4. Electronic glass sensor, Model LM335.
  - 5. Wall mounted transmitter.

### 2.5 STEAM PIPING

- A. Stainless Steel:
  - 1. ASTM A 312, Type 316L Stainless Steel
  - 2. Schedule 10S.

3. Fittings: ASTM A 403, Type 316L Stainless Steel.
4. Elbows: Long radius.
5. Joints: butt welded.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Protection:
  1. Maintain humidifier tank covers and shrouds in place at all times.
  2. Cover shroud louvers and plug piping connections to protect components from construction dirt and debris.
- B. Surface Preparation:
  1. Provide clean and level housekeeping pad to support equipment.

#### **3.2 INSTALLATION**

- A. Install humidifier electrical connections in accordance with Divisions 26, 27 and 28 - Electrical.
- B. Install the RO water supply in accordance with Section 22 11 00 - Domestic Water Piping and Specialties. Verify that appropriate water pressure is available. Provide a minimum of 24" of stainless steel piping at the connection to the humidifier in accordance with manufacturer's installation instructions.
- C. Install water tempering device and indirect condensate drains for humidifier and steam dispersion panels in accordance with Section 22 14 00 - Sanitary Waste and Vent Piping and as shown.
- D. Connect humidifiers to dispersion panels using stainless steel piping and fittings specified. Size steam pipe diameter based on actual pipe length in accordance with IO&M manual sizing table. Slope steam piping in accordance with manufacturer's recommendations to provide proper condensate drainage. Install fiberglass insulation and canvas jacketing in accordance with Section 20 07 00 - Mechanical Insulation.
- E. Install remote humidity sensing devices at the main return duct for each air handling system at the locations shown and connect to the applicable humidification unit management system in accordance with the manufacturer's written installation instructions. Provide additional humidity sensors within each conditioned space at the locations show for local humidity monitoring. Connect such that either humidity sensor (duct mounted or remote) can be used to control an air handling units humidification system.
- F. Connect each humidification system to the BAS for enable/disable control and trouble alarm monitoring.

#### **3.3 CONSTRUCTION**

- A. Interface with Other Work:
  1. Fully coordinate and sequence installation of each humidification system component with trades responsible for portions of this and other related sections of the Project Manual.
  2. Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related work shall be completed at no additional expense to the Department's Representative.

#### **3.4 REPAIR/RESTORATION**

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### **3.5 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Manufacturer's Field Services: Field verify humidification system is installed and operational in accordance with the manufacturer's written installation instructions.

### **3.6 ADJUSTING**

- A. Test, adjust and balance terminal heating equipment in accordance with Section 23 05 93 – Testing, Adjusting and Balancing. Make necessary corrections and adjustments as required by the Balancing and Testing Agency in a timely manner.
- B. Adjust humidification management system programmable setpoints as follows:
  - 1. Zone relative humidity set point: See Section 25 09 00 – Sequences of Operation.
  - 2. High limit relative humidity set point: See Section 25 09 00 – Sequences of Operation.
  - 3. Auto drain/flush sequence interval: Factory default.
  - 4. Auto drain duration: Factory default.
  - 5. Auto flush duration: Factory default.
  - 6. PID Loop: Factory default.
- C. Verify remote enable, set point adjustment and system monitoring from remote BAS terminal.

### **3.7 CLEANING**

- A. Upon completion of installation and prior to initial start-up, vacuum clean and wipe down external system components, internal shrouded areas and inside control cabinet.
- B. Flush tank and drain piping with clean water to remove debris prior to initial fill.

### **3.8 SYSTEM START-UP**

- A. Start-up and operate humidification systems in accordance with the manufacturer's written installation and operation manuals.
- B. Verify proper operational sequences in accordance with Section 25 09 00 – Sequence of Operation.
- C. Demonstrate proper system operation both locally utilizing both the humidification management system keypad and remotely through the building automation system.

**END OF SECTION 23 84 00**

**SECTION 25 50 00**  
**BUILDING AUTOMATION AND CONTROL**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section describes requirements, products, and methods of execution relating to the field hardware related to building automation controls system for the project.
- B. Refer to related sections for other technical requirements, products, and methods of execution relating to the controls system for monitoring and control of mechanical systems.
- C. Related Sections:
  - 1. 01 91 00 – Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 20 05 53 - Mechanical Identification
  - 4. 21 11 00 - Fire Protection
  - 5. 22 11 00 - Domestic Water Piping and Specialties
  - 6. 22 11 23 - Packaged Lift Station
  - 7. 22 14 23 - Storm Drainage Piping
  - 8. 23 05 93 - Testing, Adjusting and Balancing
  - 9. 23 11 13 - Fuel Oil Piping and Specialties
  - 10. 23 13 23 - Aboveground Storage Tanks
  - 11. 23 21 13 - Hydronic Piping and Specialties
  - 12. 23 21 14 - HVAC Pumps
  - 13. 23 31 00 - Ducts and Accessories
  - 14. 23 34 00 - Fans
  - 15. 23 36 00 - Air Terminal Units
  - 16. 23 36 16 - Laboratory Ventilation Systems
  - 17. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 18. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 19. 23 64 00 - Packaged Water Chillers
  - 20. 23 70 00 - Central Air Handling Units
  - 21. 23 72 13 - Dedicated Outside Air Units
  - 22. 23 81 00 - Storage Vault HVAC Equipment
  - 23. 23 81 16 - Room Air-Conditioning Units
  - 24. 23 82 00 - Terminal Heating and Cooling Units
  - 25. 23 83 00 - Radiant Floor Heating Equipment
  - 26. 23 83 01 - Snow Melting Equipment
  - 27. 23 84 00 - Humidification Equipment
  - 28. 25 09 00 - Sequences of Operation
  - 29. 25 55 00 - Variable Speed Drives

**1.2 DESCRIPTION OF WORK**

- A. This section specifies the requirements for the Building Automation System (BAS) to be installed in conjunction with this project.
- B. Provide a fully integrated building automation system, incorporating direct digital control (DDC) for HVAC system control, monitoring and management.
- C. Materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- D. Provide BAS control wiring for a complete and operable BAS system. Install wiring in accordance with Divisions 26, 27 and 28.

### 1.3 WORK BY OTHERS

- A. Products provided by BAS Contractor for installation by the Mechanical Contractor:
  - 1. Control valves.
  - 2. VAV box controllers.
  - 3. Wells for hydronic temperature sensors.
- B. Products provided by Mechanical Contractor:
  - 1. VAV boxes: BAS Contractor shall furnish VAV terminal equipment controllers to the VAV terminal unit manufacturer for factory installation at the expense of the VAV terminal unit manufacturer.
  - 2. VAV box controller enclosures will be provided by VAV terminal unit manufacturer.
  - 3. Gauges, thermometers and thread-o-lets for BAS Contractor furnished control sensor wells.
  - 4. Airflow measuring stations.
  - 5. Control and balancing dampers.
  - 6. Smoke and smoke/fire dampers with actuators.
- C. Products provided by Electrical Contractor:
  - 1. Wiring of all power feeds through disconnect starters to electrical Motors.
  - 2. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS Contractor.
  - 3. Duct smoke detectors including installation and wiring.
  - 4. Power wiring of all smoke/fire dampers provided by Mechanical Divisions 20, 21, 22, 23 and 25.
  - 5. Stand-alone packaged controls and wiring of stand-alone packaged controls to their remote sensors and devices.
  - 6. Ethernet drop at or near designated BAS control panel(s).
  - 7. Mounting and wiring of Variable Speed Drives (VSDs) furnished by the BAS Contractor per Divisions 20, 21, 22, 23 and 25.
- D. Products to receive integration under this section:
  - 1. Variable Speed Drives. VSDs shall connect directly to the BAS system through three twisted pair for Start/Stop, speed control and remote communications. VSDs shall be factory-furnished with the appropriate communication hardware and software to allow communication over the BAS FLN. Connections to VSD will be provided under this Section.
  - 2. Fire Alarm/Life Safety System. The BAS shall communicate with the fire alarm/life safety system via an alarmable point in the form of a dry contact. The device will be provided and terminated by Divisions 26, 27 and 28. This Section will provide wiring to the termination device.

### 1.4 SUBMITTALS/IO&M MANUALS

- A. Refer to Section 20 00 00 – Mechanical General Requirements for general submittal requirements.
- B. Product Data:
  - 1. Provide manufacturer's literature that fully demonstrates compliance with the manufacturing methods, appurtenances and salient features specified.
  - 2. Equipment tagging method specifically listing each device and the identification tag to be applied.
  - 3. Sequence of Operations
  - 4. Riser Diagrams
  - 5. Control Diagrams
  - 6. Panel layouts
  - 7. Valve and Damper schedules
  - 8. Point Summary Report
  - 9. Blank (Reserved for Enhanced Alarm Report)

- C. Quality Control/Control Submittals:
  - 1. Pre-functional Installation (PC) and Functional Performance Test (FC) Checklists in accordance with Section 01 91 00 – Commissioning.
  - 2. Incorporate BAS control requirements into the applicable equipment PC/FC checklists
- D. The IO&M Manuals will consist of the following (Progression from Submittal to IO&M Manual takes place using the same binders):
  - 1. Sequence of Operations
  - 2. Riser Diagrams
  - 3. Control Diagrams
  - 4. Panel layouts
  - 5. Valve and Damper schedules
  - 6. Point Summary Report
  - 7. Enhanced Alarm Report
  - 8. Commented PPCL (Program Code)
  - 9. Trend Logs
  - 10. Product Data including items reused from existing control system as noted.
  - 11. Electronic Plans Room file

### 1.5 QUALITY CONTROL

- A. Qualifications:
  - 1. Companies specializing in manufacturing the products specified in this section with a minimum of three (3) years documented experience.
  - 2. Acceptable Installers:
    - a. Minimum three (3) years experience in the installation, programming and start-up of building automaton system (BASs).
- B. Regulatory requirements:
  - 1. Products requiring electrical connection – Listed and classified by Underwriters Laboratories Incorporated, or by a testing firm acceptable to the Authority Having Jurisdiction.
- C. Pre-Installation Meetings:
  - 1. Fully coordinate installation of the building automation system with trades responsible for portions of this and any other related sections of the Project Manual prior to installation of any components.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  - 1. Verify equipment and associated appurtenances are delivered in original factory packaging/crating and are free from damage and corrosion.
  - 2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Department's Representative.
- B. Storage and Protection:
  - 1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.
  - 2. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage. Replace damaged items with same item in new condition.

### 1.7 WARRANTY

- A. Refer to Section 20 00 00 - General Mechanical Requirements.
- B. The warranty shall consist of a commitment by the Contractor to provide, at no cost to the Department, parts and labor as required to repair or replace such parts of the control system that prove inoperative due to defective materials or installation practices. The warranty expressly excludes routine service such as instrument calibration.

## **PART 2 - PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Management Level Network (MLN). Acceptable manufacturers are limited to the following:
  - 1. Siemens Building Technology.
  - 2. ATS Alaska.
- B. Building Level Network (BLN). Acceptable manufacturers are limited to the following:
  - 1. Siemens Building Technology.
  - 2. ATS Alaska.
- C. Floor Level Network (FLN). Acceptable manufacturers are limited to the following:
  - 1. Siemens Building Technology.
  - 2. ATS Alaska.

### **2.2 NETWORKING COMMUNICATIONS**

- A. The design of the BAS shall network an operator workstation(s) and stand-alone BAS Controllers. The network architecture shall consist of three levels; a Management Level Network (MLN) Ethernet network based on TCP/IP protocol, a high performance peer-to-peer building level network (BLN) and BAS Controller floor level local area networks (FLN). Access to the system shall be totally transparent to the user when accessing data or developing control programs.
- B. Management Level Network
  - 1. All PCs shall simultaneously direct connect to the Ethernet and Management Level Network without the use of an interposing device.
  - 2. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.
  - 3. Simultaneous user access to network limited to number of sight licenses issued to user.
  - 4. When appropriate, any BAS controller residing on the peer-to-peer building level network shall connect to Ethernet network without the use of a PC.
  - 5. Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet as well as directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network in addition to being able to download program changes to individual controllers.
  - 6. The Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3.
  - 7. Access to the system database shall be available from any client workstation on the Management Level Network.
- C. Peer-to-Peer Building Level Network (BLN)
  - 1. The system shall have the ability to support integration of third party systems (fire alarm, security, lighting, Variable Speed Drives, PLCs, condensers, boilers) via a panel mounted open protocol processor. This processor shall exchange data between the two systems for inter-process control. All exchange points shall have full system functionality as specified herein.
  - 2. Data transfer via Ethernet.
- D. Floor Level Network (FLN)
  - 1. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through BAS Controllers for transmission of global data.
- E. Personal Computer Operator Workstation
  - 1. A standard BAS workstation shall be provided for command entry, information management, network alarm management and database management functions. All

real-time control functions shall be resident in the BAS Controllers to facilitate greater fault tolerance and reliability.

2. Workstation center will be equipped with appropriately sized uninterruptible power supply (UPS).

### **2.3 CONTROL PANELS**

- A. Terminal Equipment Controllers will be mounted in enclosed control panels with screwed, removable covers.
- B. Control devices located in exposed areas subject to outside weather conditions or near circulator pumps (spray due to shaft seal failures) shall be mounted inside weatherproof enclosures. Location of each panel shall be convenient for adjustment service.
- C. Nameplates shall be provided beneath each panel face mounted control device describing the function of each device. Nameplates shall have white letters engraved on blue Lamicaid, or approved equal.
- D. Control panels shall bear a UL label compatible with the application.
- E. Electrical devices within the panel shall pre-wired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.
- F. BLN level controllers shall be provided with standby/emergency power to provide power quality and minimum 15 minutes operation.

### **2.4 ELECTRIC DAMPER AND VALVE ACTUATORS**

- A. The operators shall have ample power to overcome friction of damper linkage, air pressure acting on the damper blades and differential fluid pressures, as applicable.
- B. Actuators up to 2 in. diameter: Electric-gear driven or electric-hydraulic drives.
- C. Actuators 2 in. diameter and above: Electric-hydraulic assist drives.
- D. Air damper operator mounting arrangement shall be outside the air stream wherever possible. The operators shall have external adjustable stops to limit the stroke.
- E. The operator arrangement shall be such as to permit normally open or normally closed positions of dampers and valves as indicated on Drawings.
- F. Where required by the Sequence of Operations, valves shall be capable of being sequenced with other valves or other devices. Where such sequencing is required, the actual spring range, when adjusted for spring shift, shall be such that no overlapping occurs. In the event that spring shift causes overlap, pilot-positioning operators shall be furnished.

### **2.5 AUTOMATIC CONTROL VALVES**

- A. Automatic control valves shall be fully proportioning with modulating plugs for equal percentage or linear flow characteristics. The valves shall be sized by the Contractor for proper flow control characteristics and provided with actuators of sufficient power for the duty intended. Valve body and actuator selection shall be sufficient to handle system pressure and shall close against the differential pressures expected to be encountered on the project. Butterfly valves are not acceptable.
- B. Valves - 1/2 in. through 1 in. diameter: Valves shall be constructed with cast iron, brass or stainless bodies. Trim shall consist of a removable cage providing valve plug guiding throughout the entire travel range. A stainless steel stem shall be provided. Bonnet, cage and the stem and plug assembly shall be removable for servicing. Actuator shall be cast aluminum with spring-return piston operated by synthetic rubber diaphragm. Body rating shall be 400-PSI at 150 degrees F.
- C. Valves - 1-1/2 in. through 2 in. diameter: Valves shall be constructed with cast iron, brass or stainless bodies. For special duty, valves may be selected by SBT to have either bronze or

cast iron bodies with screwed or flanged ends. Valves shall have either piston or diaphragm actuators as required.

- D. Valves - 2-1/2 in. diameter and above: Valves shall be constructed with cast iron, brass or stainless bodies and have flanged connections.
- E. Valves shall be selected for maximum 3.0-PSI pressure drop through valve at design flow.
- F. Unless otherwise noted, heating valves shall fail normally open, cooling valves normally closed.

## **2.6 SENSORS**

- A. All electronic temperature sensors shall be standard resistance type for all temperature ranges. All electronic temperature sensors shall be factory calibrated and of tamper proof construction requiring no field calibration. Temperature sensor accuracy shall be a minimum of +/- 1%. To insure system accuracy, a common sensor shall be used for each control loop to provide control, indication (local and central), alarm indication (local and central) and where multi-control functions, such as discharge temperature control with compensation and positive high and low limits are used.
- B. Where the sensor is used for sensing of mixed air temperature or air handler coil discharge temperatures, and/or the duct area cross-section is in excess of 14 square feet, the instrument shall incorporate an averaging element. Outside air sensing shall be accomplished using a sensing element and transmitter shielded from the effects of sunlight.
- C. Sensors shall be furnished in scale ranges compatible with system operating range.
- D. Where sensors are used for sensing liquid temperatures, they shall be furnished with separable wells or appropriate material.
- E. Monitor VAV discharge air temperatures.

## **2.7 THERMOSTATS**

- A. Electronic Room Temperature Sensors: Shall be thermistor type with 55 degree F to 95 degree F range. Optional features include: LED display, slider bar and night setback button. Covers shall be robust, of institutional quality, suitably finished. Covers will be sensing only unless otherwise noted to include optional features. Siemens Series 1000 sensing only.
- B. Line-voltage Thermostats: Shall have bi-metal switches with a rating of at least 1.2 times the load they are handling. Covers will be sensing only.
- C. Provide locking covers or gym guards as needed.

## **2.8 PRESSURE GAUGES AND THERMOMETERS**

- A. Shall be provided and installed by mechanical Contractor.

## **2.9 RELAYS AND SIGNAL TRANSMITTERS**

- A. All necessary relays and signal boosters shall be furnished to make the system a full and operable system as required by the Sequence of Operations.

## **2.10 HIGH AND LOW LIMIT THERMOSTATS**

- A. Low limit thermostats shall employ a 20-foot element. If any one-foot section of the element is subjected to temperatures below 35 degrees F (adjustable), the respective electric or pneumatic circuit shall open causing action to Fans and dampers as required under the Sequence of Operation.
- B. High limit thermostats shall employ rod and tube type elements that extend approximately ten inches into the duct. If instrument is subjected to temperatures above 135 degrees F, action

required by Sequence of Operations shall occur. Where high limit is required for Fire Protection, such thermostats shall be UL listed for Fire Protection.

- C. Shall be manual reset or automatic reset with time delay. Manual resets will have alarmable contacts.

### **2.11 AIR AND WATER FLOW PROOF DEVICES**

- A. Provide current operated relays as standard proof devices. Pressure differential switches may be used as directed. Paddle type flow switches are not acceptable.
  - 1. Provide solid-state, adjustable, current operated relay. Provide a relay that changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
  - 2. Adjust the relay switch point so that the relay responds to motor operation under load as an ON state and so that the relay responds to an unloaded running motor as an OFF state. A motor with a broken belt is considered an unloaded motor.
- B. Provide status device for Fans, Motors and pumps.

### **2.12 ACCESS PANELS**

- A. Access panels provided by Division.
- B. Coordinate access panel location with Department's Representative and Division 08.
- C. Provide access to concealed control devices.

### **2.13 PNEUMATIC TUBING**

- A. Provide color coded, flame retarded, crack resistant, polyethylene tubing for installation in concealed areas, in control cabinets and inside conduit raceways. Dekoron FR or equal.
  - 1. Plenum Rated.
  - 2. Environmental stress crack resistance: ASTM D 1693, 0 percent failure in 48 hours.
  - 3. Acceptable manufactures include, but are not limited to the following:
    - a. Dekoron FR.
    - b. Alternate Brand Request or Substitution Request not required.
- B. Concealed:
  - 1. Polyethylene connected with serrated brass fittings.
  - 2. Copper: Type "M" hard-drawn with solder joints or brass compression fittings.
- C. Exposed:
  - 1. Copper: Type "M" hard-drawn with solder joints or brass compression fittings.
- D. In Return Air Plenums:
  - 1. Polyethylene connected with serrated brass fittings.
  - 2. Copper: Type "M" hard-drawn with solder joints or brass compression fittings.

### **2.14 UNINTERRUPTIBLE POWER SUPPLY**

- A. Acceptable manufactures are limited to the following:
  - 1. Powerware.
  - 2. Alternate Brand Request or Substitution Request required.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General
  - 1. Mount damper operators and other control devices secured to insulated ductwork on brackets such that the device is external of the insulation. See Section 20 05 29 – Hangers and Supports.

2. Do not install control devices in locations where they are subject to damage or malfunction due to normally encountered ambient temperatures.
- B. Identification
1. Permanently tag controllers, switches, relays, thermostats and actuators for identification using the tagging format shown on the BAS control drawings.
- C. Sensors and Switches
1. Pump flow or fan flow, etc, shall be sensed using current switch unless indicated otherwise. Calibrate current switch to distinguish between loaded or unloaded motor condition due to belt or coupler breakage.
  2. Protect averaging or capillary tubes where they penetrate duct with rubber grommet and seal with clear silicon. Support with capillary clips and maintain minimum 1 inch tubing bending radius.
- D. Wiring
1. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. Wiring in exposed or inaccessible areas shall be installed in conduit, conduit types shall be as required in Divisions 26, 27 and 28.
  2. Provide wiring between thermostats and unit heater Motors, and control and alarm wiring.
  3. Provide conduit and wiring between the BAS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit.
  4. Provide conduit and control wiring for devices specified in this Section.
  5. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BAS panels located in the vicinity of motor control centers.
  6. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contactors, and BAS panels, as shown on the drawings or as specified.
  7. Wiring to be in accordance with Divisions 26, 27 and 28 requirements and the NEC.
  8. Provide electrical wall box and wiring routed in conduit for wall-mounted devices. Mount thermostats at 54 inches AFF unless otherwise noted.

### **3.2 SEQUENCE OF OPERATION**

- A. Programming BAS to provide system operation and monitoring in accordance with Section 25 09 00 - Sequence of Operation and other referenced sections.

### **3.3 SUBSTANTIAL COMPLETION**

- A. Demonstrate the proper operation and control of systems controlled and monitored by the BAS system.
- B. The demonstration shall include, but not necessarily be limited to, the following:
1. Review of the Trend Logs.
  2. Complete and proper operation of control systems including simulations.
  3. Access to all devices for required maintenance.
  4. Review of associated graphics on Host.

### **3.4 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.
- B. Trend Logs
1. Prepare trend logs for all points required to demonstrate BAS calibration, control and stability.
  2. Trend logs shall document building operation after applicable PC/FC checklists are completed and building site Commissioning is satisfactorily completed.

3. Set points, valve positions, etc. may be temporarily adjusted to artificially induce the intended sequences to occur.

### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide forty (40) hours of on-site instruction to familiarize operating personnel with the control system. instructions will include:
  1. A brief description of the controls' Sequence of Operation.
  2. A discussion and explanation of all alarms, switches and gauges.
  3. A summary and explanation of steps to be taken in response to specific alarms or control malfunctions.
  4. Building walk-through to physically locate and examine all control devices and demonstrate control setpoint adjustment procedures.
  5. Instructions regarding adjustment procedures shall emphasize methods for continual building "fine-tuning."

**END OF SECTION 25 50 00**

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**SECTION 25 55 00**  
**VARIABLE SPEED DRIVES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section provides specification requirements for solid-state, pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as AC Drives, for use with NEMA design AC motors. The drive manufacturer shall have an existing:
  - 1. Sales representative exclusively for HVAC/Pumping products, with expertise in HVAC/Pumping systems and controls.
  - 2. An independent service organization.
- B. The AC Drive supplier shall furnish, field test, adjust and certify installed AC Drives for satisfactory operation.
- C. Exceptions/deviations to this specification shall be indicated in writing and included with the submittal.

**1.2 QUALITY ASSURANCE**

- A. Referenced Standards:
  - 1. ANSI/NFPA 70 - National Electrical Code (NEC).
  - 2. Institute of Electrical and Electronic Engineers (IEEE): Standard 519, IEEE Guide for Harmonic Content and Control.
  - 3. UL 508 - UL Standard for Safety Industrial Control Equipment.
  - 4. UL 508C - UL Standard for Safety Power Conversion Equipment.
  - 5. NEMA ICS 7.1 - AC Adjustable Speed Drive Systems.
- B. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- C. The AC Drive and all associated optional equipment shall be UL Listed according to UL 508 C - Power Conversion Equipment. As verification, a UL label shall be attached on the inside of the combination enclosure. A UL508A panel builders label does not meet specification.
- D. The AC Drive shall be designed, constructed and tested in accordance with UL, CSA, NEMA, and NEC standards.
- E. Every power converter shall be tested with an AC induction motor while loaded and temperature cycled within an environment chamber at 40 °C (104 °F).
- F. VSDs and options shall be UL listed as a complete assembly. VSDs that require the customer to supply external fuses for the VSD to be UL listed are not acceptable. The base VSD shall be UL listed for 100 KAIC without the need for input fuses.
- G. Acceptable Manufacturers:
  - a. Approval does not relieve supplier of specification requirements.
  - b. VSDs that are manufactured by a third party and "brand labeled" shall not be acceptable.

**1.3 SUBMITTALS**

- A. Submittals shall include the following information:
  - 1. Outline dimensions, conduit entry locations and weight.
  - 2. Customer connection and power wiring diagrams.
  - 3. Complete technical product description include a complete list of options provided.
  - 4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
    - a. The VSD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5 percent.

- b. Input line filters shall be sized and provided as required by the VSD manufacturer to ensure compliance with IEEE standard 519. VSDs shall include a minimum of 3 percent impedance reactors, **no exceptions**.
- 5. Reflected wave phenomenon: Provide detailed technical information on specified output filters including specific installation requirements. Provide written approval from output filter, motor and VSD manufacturers that proposed output filter application is properly sized and applied.

#### 1.4 TRAINING

- A. Provide one (2) hours of Owner operator training on operation and service diagnostics at the time of the equipment commissioning.
- B. Training shall be conducted by the manufacturer's start-up and commissioning agents.
- C. Training shall utilize Operation and Maintenance Manuals submitted and approved for this specific project.

#### 1.5 WARRANTY

- A. Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 24/365 support available via a toll free phone number.
- B. Service availability: The supplier shall have a fully equipped service organization capable of guaranteeing response time within 48 hours of service calls to service VSD.

#### 1.6 OWNERS MANUALS

- A. Furnish two (2) complete sets of Operation and Maintenance Manuals and other information necessary for the operation and maintenance of the system unless otherwise noted in Division 1.

### PART 2 - PRODUCTS

#### 2.1 BASIS OF DESIGN

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from ABB or alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the specification.
- B. VSDs shall be Square D E-Flex enclosed drive controllers or approved equal.

#### 2.2 GENERAL DESCRIPTION

- A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
- B. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage.
- C. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
- D. The adjustable frequency drive package shall consist of a circuit breaker disconnect, line reactor, EMI/RFI filter, 120V control transformer, control circuit terminal board for digital and analog field wiring. The base VSD shall be UL listed for 100 KAIC without the need for input fuses.
- E. The drive door shall have mounted and wired, Hand-Off-Auto switch, Manual Speed Potentiometer and AFC-Off switch.
- F. The entire drive package shall be UL508C listed and coordinated with NEMA ICS 7.1. A UL508A panel builders label does not meet specification.

### 2.3 CONSTRUCTION

- A. The AC Drive power converter shall be enclosed in a NEMA Type 12 enclosure with a circuit breaker disconnect and user terminal strip connections. The enclosure shall provide dedicated user terminals for power and control device connection.
- B. Provisions shall be included for locking the disconnect in the OFF position with a padlock.
- C. Enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.

### 2.4 APPLICATION DATA

- A. The AC Drive shall be sized to operate a variable torque load.
- B. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

### 2.5 ENVIRONMENTAL RATINGS

- A. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and CSA standards.
- B. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 °C (14 to 104 °F).
- C. The storage temperature range shall be -25 to 65 °C (-13 to 149 °F).
- D. The maximum relative humidity shall be 95%, non-condensing.
- E. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive shall be de-rated per drive specifications.
- F. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.
- G. The AC Drive shall be Seismic Qualified to 2000 IBC Level 3 "Extreme" rating with an Importance Factor  $1p=1.5$

### 2.6 RATINGS

- A. The AC Drive shall be designed to operate at the input line voltage indicated on the equipment schedule.
- B. The AC Drive shall operate from an input frequency range of 60 Hz ( $\pm$ ) 5%.
- C. The displacement power factor shall not be less than 0.98 lagging under any speed or load condition.
- D. The efficiency of the AC Drive at 100% speed and load shall not be less than 97%.
- E. The variable torque rated AC Drive over current capacity shall be not less than 110% for 1 minute.
- F. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4 or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

### 2.7 PROTECTION

- A. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.
- B. The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate. Short circuit coordination to UL 508C Power Conversion Equipment and NEMA ICS 7.1.
- C. The AC Drive shall be protected against short circuits, between output phases and to ground.
- D. The AC Drive shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles).

- E. The AC drive shall have a programmable ride-through function, which shall allow the logic to maintain control for a minimum of one-second (60 cycles) without faulting.
- F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 6 programmable restart attempts. The time delay before restart attempts will be 30 seconds.
- G. Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.
- H. The AC Drive shall have a solid-state UL 508C listed overload protective device and meet IEC 60947.
- I. The output frequency shall be software enabled to fold back when the motor is overloaded.
- J. There shall be three skip frequency ranges that can be programmed to a bandwidth of  $\pm 2.5$  Hz.

## **2.8 ADJUSTMENTS & CONFIGURATIONS**

- A. The AC Drive will be factory programmed to operate specified optional devices.
- B. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.
- C. The memory shall retain and record run status and fault type of the past eight faults.
- D. The software shall have an energy economy function that, when selected, will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load. Selectable volts/Hz ratio patterns does not meet specification, the function must be automatically optimized.

## **2.9 KEYPAD DISPLAY INTERFACE**

- A. A keypad display interface shall offer the modification of AC Drive adjustments through a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible.
- B. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification portion of the LCD display.
- C. The keypad display shall have a hardware selector switch that allows the keypad to be locked out from unauthorized personnel.

## **2.10 OPERATOR CONTROLS**

- A. The control power for the digital inputs and outputs shall be 24 Vdc.
- B. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
- C. Pull-apart terminal strips shall be used on logic and analog signal connections in the power converter
- D. Two voltage-free relay output contacts shall be provided. One of the contacts shall indicate AC Drive fault status. The other contact shall indicate a drive run status.
- E. The combination enclosure shall have the following dedicated operator controls:
  - 1. Hand-Off-Auto switch
  - 2. Manual Speed Potentiometer
  - 3. AFC-Off switch

- F. The combination enclosure shall include terminal point connection for fire/freeze state interlock, to prevent drive operation. The interlock shall shut down the motor in the drive mode.

## 2.11 SERIAL COMMUNICATION

- A. The AC Drive shall have Apogee FLN P1 communications capability. The Apogee P1 communications card shall provide data communications with a host computer or other device via the Apogee FLN P1 network. Data exchanges shall give access to all drive functions:
  - 1. Control: Start, stop, reset and setpoint.
  - 2. Monitoring: Status, current, voltage, thermal state, etc.
  - 3. Diagnostics: Alarms.
- B. The graphic display terminal or the integrated display terminal shall be used to access functions for communication configuration and diagnostics.

## 2.12 HARMONIC MITIGATION

- A. Each drive shall include a minimum 3 percent line reactor mounted inside the drive enclosure to reduce power system harmonics and provide power quality protection for the drive. DC bus chokes do not meet specification and shall not be substituted.
- B. EMI / RFI filters: VSDs shall include EMI/RFI filters. The onboard filters shall allow the VSD assemble to be CE Marked and the VSD shall meet product standard EN 61800-3 for the First Environment restricted level.
- C. VSDs through 50HP shall be protected from input and output power mis-wiring. The VSD shall sense this condition and display an alarm on the keypad.
- D. Additional Features – Additional features shall be furnished and mounted by the drive manufacturer. Additional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label:
  - 1. A MANUAL BYPASS SYSTEM IS NOT DESIRED OR REQUIRED.
  - 2. Provide a door interlocked, padlockable circuit breaker that will disconnect input power from the drive and all internally mounted options.
  - 3. Provide a fused disconnect (service switch).
  - 4. The drive shall provide single-phase motor protection.
  - 5. The following operators shall be provided:
    - a. Hand-Off-Auto.
    - b. Drive mode selector.
  - 6. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided:
    - a. Power-on (Ready).
    - b. Run enable (safeties) open.
    - c. Drive mode select damper opening.
    - d. Drive running.
    - e. Drive fault.
    - f. Safety open.
    - g. Damper opening.
    - h. Damper end-switch made.
  - 7. The digital inputs for the system shall accept 24V or 115VAC (selectable).
  - 8. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. External safety interlocks shall remain fully functional whether the system is in Hand or Auto modes.
  - 9. The VSD shall include a “run permissive circuit” that will provide a normally open contact whenever a run command is provided (local or remote start command in VSD mode). The VSD system shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VSD system safety interlock (fire detector,

- freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
10. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

### **2.13 REFLECTED WAVE PHENOMENON**

- A. Provide Trans-Coil International KLC dv/dt V1k output filters where noted on the drawings to mitigate reflected wave phenomenon.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. Do not install VSD until the building environment can be maintained within the service conditions required by the manufacturer. Before and during the installation, the VSD equipment shall be protected from site contaminants.
- C. Details of the installation shall comply with the manufacturer's applicable instructions.
- D. Minimize the length of conductors between the drive and the motor to avoid motor damage from reflected wave phenomenon.
- E. Where the field conditions dictate long lengths of conductors between the VSD and motor (e.g. remote well pumps), provide necessary measures (output filters) to protect motors from reflected wave phenomenon. Installation shall be in accordance with the VSD and motor manufacturer's recommendations.
- F. Mounting of VSD shall be suitable for seismic anchorage and/or restraints as required by International Building Code.
- G. VSDs shall be furnished under Mechanical Divisions 20, 21, 22, 23 and 25 and installed under Electrical Divisions 26, 27 and 28. The contractor shall install the drive in accordance with the recommendations of the VSD manufacturer as outlined in the installation manual.
- H. Power wiring shall be provided under Electrical Divisions 26, 27 and 28. The contractor shall complete wiring in accordance with the recommendations of the VSD manufacturer as outlined in the installation manual.

### **3.2 CONTROL WIRING**

- A. Control wiring and control devices shall be provided under the specification section in which the controlled equipment is specified. Coordinate related work.
- B. Control wiring shall be routed completely separately from power wiring.

### **3.3 NAMEPLATES**

- A. Provide a nameplate for each VSD. Coordinate names with mechanical equipment lists.

### **3.4 START-UP**

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file by the manufacturer.

### **3.5 PRODUCT SUPPORT**

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the VSD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

- B. Onsite training shall be provided as part of the startup service. The training shall include installation, programming and operation of the VSD and serial communication.

**END OF SECTION 25 55 00**

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**SECTION 25 90 00**  
**SEQUENCE OF OPERATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes: This section describes the building automation system (BAS) control sequences for the heating, ventilating and air-conditioning (HVAC) systems, electrical systems and plumbing systems provided for this project.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 20 00 00 - Mechanical General Requirements
  - 3. 22 11 00 - Domestic Water Piping and Specialties
  - 4. 22 11 23 - Packaged Lift Station
  - 5. 22 14 00 - Sanitary Waste and Vent Piping
  - 6. 22 14 23 - Storm Drainage Piping
  - 7. 22 15 13 - Compressed Air Systems
  - 8. 22 40 00 - Plumbing Fixtures
  - 9. 23 11 13 - Fuel Oil Piping and Specialties
  - 10. 23 13 23 - Aboveground Storage Tanks
  - 11. 23 21 13 - Hydronic Piping and Specialties
  - 12. 23 21 14 - HVAC Pumps
  - 13. 23 34 00 - Fans
  - 14. 23 35 00 - Industrial Ventilation Systems
  - 15. 23 36 00 - Air Terminal Units
  - 16. 23 36 16 - Laboratory Ventilation Systems
  - 17. 23 52 13 - Electric Hydronic Boilers and Accessories
  - 18. 23 52 23 - Cast Iron Hydronic Boilers and Accessories
  - 19. 23 70 00 - Central Air Handling Units
  - 20. 23 81 00 - Storage Vault HVAC Equipment
  - 21. 23 81 16 - Room Air-Conditioning Units
  - 22. 23 82 00 - Terminal Heating and Cooling Units
  - 23. 23 83 00 - Radiant Floor Heating Equipment
  - 24. 23 83 01 - Snow Melting Equipment
  - 25. 23 84 00 - Humidification Equipment
  - 26. 25 50 00 - Building Automation and Control
  - 27. 25 55 00 - Variable Speed Drives

**1.2 SUBMITTALS**

- A. Refer to 20 00 00 - Mechanical General Requirements.
- B. Product Data:
  - 1. Provide BAS manufacturers' product literature, clearly annotated to indicate performance criteria to include the following:
    - a. Building level to floor level network controller riser diagrams. Include building locations and equipment controlled by each controller.
    - b. Sequences of operation for HVAC, electrical and plumbing systems.
    - c. Process control diagrams to support each Sequence of Operation. Show field mounted control device locations and circuit routing.
    - d. Complete electrical and pneumatic BAS points list.
- C. Installation, Operation and Maintenance Data:
  - 1. Provide approved submittal information, revised to reflect the actual installation and set point adjustments made during the Commissioning process.

- D. Quality Control/Control Submittals:
  - 1. Pre-functional Installation (PC) and Functional Performance Test (FC) Checklists in accordance with Section 01 91 00 – Commissioning.
  - 2. Installation and Functional Performance Test Letter:
    - a. Provide a letter certifying that the building automation system hardware is installed and each Sequence of Operation has been programmed, operationally tested and physically verified to comply with the specified sequences of operation.
    - b. Include as an attachment, a list of programming deviations from the specified sequences of operation with justification to support each deviation.
    - c. Include as an attachment, a table of final adjustable set point values for each applicable control point.

### 1.3 QUALITY CONTROL

- A. Qualifications:
  - 1. Acceptable Installers/Programmers:
    - a. Minimum three (3)-years experience in the installation and programming of direct digital control systems.
- B. Pre-Installation Meetings:
  - 1. Conduct coordination meetings, as necessary, to evaluate and coordinate the connection of the BAS to each piece of HVAC, electrical and plumbing equipment. Where the BAS is to be connected to packaged, stand-alone controllers, coordinate BAS remote control and monitoring capabilities with the specific features of the packaged controller to maximize remote operability and monitoring of each packaged controller through the BAS.

## PART 2 - PRODUCTS - NOT USED

## PART 3 - EXECUTION

### 3.1 BUILDING AUTOMATION SYSTEM LIGHTING ZONES

- A. The building is divided into BAS lighting control zones based on space usage. BAS lighting control zones are shown on the electrical floor plans and listed below.
- B.
  - Interior Zones:
    - 1. Public
    - 2. Maintenance
    - 3. Museum
    - 4. Library
    - 5. Back of House
    - 6. Staff
    - 7. Coffee Bar
  - Exterior Zones:
    - 1. Site
    - 2. Site Accent (Nimbus)
    - 3. Site Plaza
    - 4. Site Flag

### 3.2 BUILDING INTERIOR NORMAL LIGHTING CONTROL

- A. Each interior lighting control zone listed above shall receive one BAS control point. The interior lighting zones are to be controlled by the building automation system through the lighting control system. The lighting control may be overridden by the users through local switches. Coordinate with Division 26 for properties of the lighting control system.

- B. Turn on interior lighting automatically via the lighting control system:
  - 1. At a set time at the direction of the Owner. Final programming shall reflect the times provided by the Owner and shall account for a 365-day schedule including special hours for different seasons, weekends and holidays. Submit request to the Department to obtain Owner's time schedule for lighting operation.
  - 2. Manually via the BAS at the discretion of the operator.
  - 3. In coordination with the fire alarm system when an alarm is received.
  - 4. In coordination with the access control system when an alarm is received.
  - 5. In coordination with the remote access employee system. Provide remote access via phone or web interface.
- C. Turn off interior lighting automatically via the lighting control system:
  - 1. At a set time at the direction of the Owner. Final programming shall reflect the times provided by the Owner and shall account for a 365-day schedule including special hours for different seasons, weekends and holidays. Submit request to Contracting Agency to obtain Owner's time schedule for lighting operation.
  - 2. Manually via the BAS at the discretion of the operator.
  - 3. After a set period of time at the direction of the Owner, if turned on by the remote access employee system.

### 3.3 EXTERIOR LIGHTING CONTROL

- A. Each exterior lighting control zone listed above shall receive one BAS control point. The exterior lighting zones are to be controlled by the building automation system through the lighting control system. The lighting control may be overridden by the users through local switches. Coordinate with Division 26 for properties of the lighting control system.
- B. Connect to the exterior photocell furnished in Division 26 and utilize in the sequences described below.
- C. Turn on exterior lighting automatically via the lighting control system:
  - 1. At a set time at the direction of the Owner. Final programming shall reflect the times provided by the Owner and shall account for a 365-day schedule including special hours for different seasons, weekends and holidays. Submit request to Contracting Agency to obtain Owner's time schedule for lighting operation.
  - 2. Upon activation of the exterior mounted photocell due to nightfall.
  - 3. Manually via the BAS at the discretion of the operator.
  - 4. In coordination with the Fire Alarm System when an alarm is received.
  - 5. In coordination with the access control system when an alarm is received.
- D. Turn off exterior lighting automatically via the lighting control system:
  - 1. At a set time at the direction of the Owner. Final programming shall reflect the times provided by the Owner and shall account for a 365-day schedule including special hours for different seasons, weekends and holidays. Submit request to Contracting Agency to obtain Owner's time schedule for lighting operation.
  - 2. Upon de-activation of the exterior mounted photocell due to daybreak.
  - 3. Manually via the BAS at the discretion of the operator.
  - 4. Release manual lighting overrides upon photocell switch change of state.

### 3.4 GENERATOR

- A. Generator Operation:
  - 1. See Section 26 30 00 – Emergency Standby Generation System for generator sequences of operation.
- B. Electrical Load Sequencing:
  - 1. Limit starting surge on emergency generator by sequencing controlled motors "ON", one at a time at not less than five (5)-second (adjustable) intervals.

2. Limit all motors controlled by variable speed drives to 60 percent (adjustable) of full load when operating on generator power.
- C. Generator shall be monitored for the following conditions:
  1. Run status (including totalized run time).
  2. Common pre-alarm (any alarm condition that does not prevent the generator from operating).
  3. Common alarm (any alarm condition that prevents the generator from providing power).
  4. Low fuel condition.
- D. Generator Load Shed Control:
  1. During the commissioning process, identify and program up to 10 significant loads that will be turned off in order of priority based on dynamic generator load information.
    - a. Nominally, if the generator reaches 90 percent of rated load, the BAS shall begin shedding load until the generator load falls below 87 percent of rated load.
    - b. Coordinate with Department and Engineer of Record for loads at commissioning.
- E. Emergency Generator Alarm:
  1. Provide alarm if generator runs more than 60 minutes (adjustable) at any one time.
- F. Generator load sequencing: Limit starting surge on generator by sequencing controlled Motors "on," one at a time at not less than 10 second intervals.

### 3.5 ELECTRIC HEAT TRACE CONTROL

- A. Turn on roof drain/rain leader heat trace system when outside air temperature drops to 32 degrees F and decreasing (adjustable). Turn off heat trace when outside air temperature rises to 35 degrees F and increasing (adjustable).
- B. Utilize the BAS to monitor current for each individual storm drain heat circuit.

### 3.6 CENTRAL VENTILATION SYSTEM OVERVIEW

- A. General Ventilation System Description: The forced air heating, ventilating and air-conditioning system consists of six (6) centralized air handling systems and three (3) dedicated local ventilating systems to serve the facility.
  1. AHU-1 provides a constant volume air flow rate to precisely control the Secure Collections 124 air exchange rate and provide a homogenous environment for its contents:
    - a. Primary Control: RH (45 % RH  $\pm$  8%)
    - b. Secondary Control: Temperature(60 Deg F  $\pm$  4 Deg F)
  2. AHU-2 provides a constant volume air flow rate to precisely control the Secure Storage 227 air exchange rate and provide a homogenous environment for its contents:
    - a. Primary Control: RH (45 % RH  $\pm$  10%)
    - b. Secondary Control: Temperature (60 Deg F  $\pm$  4 Deg F)
  3. AHU-3 provides a constant volume air flow rate to precisely control the Museum Exhibit areas air exchange rate and provide a homogenous environment for its contents:
    - a. Primary Control: RH (45 % RH  $\pm$  8%)
    - b. Secondary Control: Temperature (70 Deg F  $\pm$  4 Deg F)
  4. AHU-4 utilizes a variable air volume system to precisely control the Reading/Research and related second floor administrative areas:
    - a. Primary control: Temperature (72 Deg F  $\pm$  2 Deg F)
    - b. Secondary control: RH (30 to 60%) with cold weather setback control to prevent window condensation.
  5. AHU-5 utilizes a variable air volume system to precisely control the main entry, first and second floor lobbies, café, auditorium, administration, staff and technical service and general use areas:
    - a. Primary control: Temperature (72 Deg F  $\pm$  2 Deg F)

- b. Secondary control: RH (30 to 60%) with cold weather setback control to prevent window condensation.
- 6. AHU-6 utilizes a variable air volume supply/exhaust system for precise temperature, RH and pressure control of the laboratory suite:
  - a. Primary Control: RH (45 % RH  $\pm$  8%)
  - b. Secondary Control: Temperature(70 Deg F  $\pm$  4 Deg F)
- 7. SCF-1A and SCF-1B provides a once through (100% outside air) ventilation system and negative pressure control for the wood shop/metal shop with respect the rest of the building and also provides the make-up air source for the paint booth and sawdust collection exhaust systems.
  - a. Primary control: Temperature (72 Deg F  $\pm$  2 Deg F)
  - b. RH Range: No humidity control.
- 8. SCF-2 and SCF-3 provide general ventilation and economizer cooling for Boiler Room 121 and Electrical Rooms 122/123 respectively.
  - a. Primary control: Temperature (75 Deg F  $\pm$  2 Deg F)
  - b. RH Range: No humidity control.

### 3.7 AHU-1 VAULT VENTILATION SYSTEM OPERATION (SECURE COLLECTIONS 124)

- A. Ventilation System Operation:
  - 1. Full Shutdown Mode:
    - a. Dedicated Outside Air Unit (DOA-1):
      - 1). DOA-1 off and intake and exhaust dampers shut
    - b. Supply Fans:
      - 1). Supply fans off.
      - 2). Heating coil (HC-1) hydronic control valve shut.
      - 3). Cooling coil (C-1) control valve shut.
      - 4). Humidification system (H-1) off.
    - c. Hydronic Heating System:
      - 1). See hydronic heating system sequence of operations.
    - d. Cooling System:
      - 1). See well water cooling system sequence of operations.
    - e. Humidification System
      - 1). See humidification system sequence of operations.
  - 2. Air-Handler Start Sequence:
    - a. AHU-1 system typically runs continuously to provide a homogenous, controlled environment for Secure Collections 124 as a single zone; however, provide independent, adjustable, automatic start/stop sequence for air-handling system based on time-of-day schedule initially set for 24 hour operation.
  - 3. Supply Fan Speed Control:
    - a. Locate duct static pressure sensors in main supply air duct, approximately 3/4 the distance between the AHU-1 supply outlet and the end of the longest supply duct run.
    - b. Control supply fan speed, through the variable speed drive (VSD) controllers, to maintain supply branch duct pressure at 1.5 inch W.C. set point pressure (adjustable). Fan speed will be adjusted in the field to optimize ventilation air recirculation rate during commissioning.
    - c. If one supply fan VSD controller fails, stop associated supply fan and shut its dedicated two-position supply fan inlet damper (to prevent local recirculation air flow of the operating fan). Send "AHU-1 – Supply Fan 1" or "AHU-1 – Supply Fan 2" trouble alarm as applicable to the BAS.
    - d. If both supply fans fail, shift to Full Shutdown Mode and send "AHU-1 – System Shutdown" trouble alarm to the BAS.

4. Dedicated Outside Air Unit (DOA-1):
  - a. Allow AHU-1 system to recirculate the zone air volume for 30 minutes before starting DOA-1. Start DOA-1 utilizing packaged controls and operate with a 30 minute delayed start (adjustable) whenever AHU-1 system is operating.
  - b. Adjust and balance DOA-1 supply and exhaust fan VSD controllers for air intake and exhaust air flow rates as scheduled (See scheduled IAQ Documentation (M004)) to maintain the zone at a neutral building pressure relative to ambient.
  - c. Modulate electric preheat coil (PHC-1) to limit enthalpy wheel inlet temperature to no less than 10 Deg F. Bypass PHC-1 when outside air temperature is greater than 10 Deg F.
  - d. Utilize the DOA-1 packaged controls to modulate desiccant wheel face/bypass dampers and desiccant regeneration rate to control the moisture addition rate to the zone utilizing a return duct mounted relative humidity sensor.
5. AHU-1 Humidity and Temperature Control:
  - a. Outside air is "pre-conditioned" by DOA-1 and provides a percentage of fresh outside air ventilation utilizing a "feed and bleed" process.
  - b. Measure relative humidity using a common return duct mounted relative humidity sensor.
  - c. Measure air recirculation temperature using a duct averaging flexible sensor mounted across the AHU-1 inlet plenum.
  - d. Modulate heating coil hydronic control valve to control zone temperature to maintain 60 Deg F set point (adjustable) measured from return duct mounted temperature sensor.
  - e. If zone temperature exceeds heating set point, shut heating coil (HC-1) control valve and modulate coiling coil (CC-1) hydronic control valve to control zone temperature to set point temperature.
  - f. Control zone relative humidity utilizing DOA-1 packaged controls and return duct mounted relative humidity sensor to 45 % RH minus 5%.
  - g. If minimum relative humidity set point cannot be maintained modulate humidification system (H-1) to maintain zone minimum relative humidity to 40% minimum (adjustable).
6. Temperature and Relative Humidity Monitoring;
  - a. Provide wall mounted temperature and relative humidity sensors with local Temp/RH display at the locations shown. Provide remote monitoring of the sensors from the BAS and the ability to utilize the sensors as control points if desired.

### **3.8 AHU-2 VAULT VENTILATION SYSTEM OPERATION (SECURE STORAGE 227)**

- A. Similar to AHU-1 system operation for Secure Storage 227 utilizing dedicated outside air unit DOA-2 and humidification system H-2.

### **3.9 AHU-3 MUSEUM/EXHIBIT VENTILATION SYSTEM OPERATION**

- A. Ventilation System Operation:
  1. Full Shutdown Mode:
    - a. Dedicated Outside Air Unit (DOA-3):
      - 1). DOA-3 off and intake and exhaust dampers shut
    - b. Supply Fans:
      - 1). Supply fans off.
      - 2). Heating coil (HC-3) hydronic control valve shut.
      - 3). Cooling coil (C-3) control valve shut.
      - 4). Humidification system (H-3) off.
    - c. Hydronic Heating System:
      - 1). See hydronic heating system sequence of operations.
    - d. Cooling System:
      - 1). See well water cooling system sequence of operations.

- e. Humidification System
  - 1). See humidification system sequence of operations.
2. Air-Handler Start Sequence:
  - a. AHU-3 system typically runs continuously to provide a homogenous, controlled environment for Museum Exhibit zones: however, provide independent, adjustable, automatic start/stop sequence for air-handling system based on time-of-day schedule initially set for 24 hour operation.
3. Supply Fan Speed Control:
  - a. Locate duct static pressure sensors in main supply air duct, approximately 3/4 the distance between the AHU supply outlet and most remote zone variable air volume (VAV) terminal unit branch duct connection. If multiple supply air duct branches exist, provide a separate static pressure sensor in each main branch duct, located approximately 3/4 of the distance between the AHU supply outlet and the most remote zone terminal unit branch connections.
  - b. Compare branch duct pressure readings and control supply fan speed, through the variable speed drive (VSD) controller, to maintain the lowest branch pressure at 1.5 in WC set point pressure (adjustable).
  - c. If one supply fan VSD controller fails, stop associated supply fan and shut its dedicated two-position supply fan inlet damper (to prevent local recirculation air flow of the operating fan). Send "AHU-3 – Supply Fan 1" thru "AHU-3 – Supply Fan 4" trouble alarm as applicable to the BAS.
  - d. If all supply fans fail, shift to Full Shutdown Mode and send "AHU-3 – System Shutdown" trouble alarm to the BAS.
4. Dedicated Outside Air Unit (DOA-3):
  - a. Allow AHU-3 system to recirculate the zone air volume for 30 minutes before starting DOA-3. Start DOA-3 utilizing packaged controls and operate with a 30 minute delayed start (adjustable) whenever AHU-3 system is operating.
  - b. Adjust and balance DOA-3 supply and exhaust fan VSD controllers for air intake and exhaust air flow rates as scheduled (See scheduled IAQ Documentation (M004)) to maintain the zone at a neutral building pressure relative to ambient.
  - c. Modulate electric preheat coil (PHC-3) to limit enthalpy wheel inlet temperature to no less than 10 Deg F. Bypass PHC-3 when outside air temperature is greater than 10 Deg F.
  - d. Utilize the DOA-3 packaged controls to modulate desiccant wheel face/bypass dampers and desiccant regeneration rate to control the moisture addition rate to the AHU-3 system utilizing a return duct mounted relative humidity sensor.
5. AHU-3 Humidity and Temperature Control:
  - a. Outside air is "pre-conditioned" by DOA-3 and provides a percentage of fresh outside air ventilation utilizing a "feed and bleed" process.
  - b. Measure relative humidity using a common return duct mounted relative humidity sensor.
  - c. Measure air recirculation temperature using a duct averaging flexible sensor mounted across the AHU-3 inlet plenum.
  - d. Modulate heating coil hydronic control valve to maintain fifty-five (55) degree supply air set point temperature (adjustable) measured downstream of the supply fan.
  - e. If supply air temperature exceeds heating set point, shut heating coil (HC-3) control valve and modulate coiling coil (CC-3) hydronic control valve to supply air temperature to set point.
  - f. Control system relative humidity utilizing DOA-3 packaged controls and return duct mounted relative humidity sensor to 45 % RH minus 5%.
  - g. If minimum relative humidity set point cannot be maintained modulate humidification system (H-3) to maintain zone minimum relative humidity to 40% minimum (adjustable).

6. Temperature and Relative Humidity Monitoring;
  - a. Provide wall mounted temperature and relative humidity sensors with local Temp/RH display at the locations shown. Provide remote monitoring of the sensors from the BAS and the ability to utilize the sensors as control points if desired.
- B. Constant Volume Relative Humidity/Temperature Control with Auxiliary Radiant Floor Heating:
  1. AHU-3 VAV terminal units operate in constant volume (CV) mode.
  2. Zone Sensors:
    - a. Zone Thermostat: Provide wall-mounted zone thermostats with input to applicable zone VAV terminal equipment controllers.
    - b. Provide separate slab floor temperature sensors for radiant floor zones (RHZ-11 thru 19). See Section 23 83 00 – Radiant Floor Heating Equipment.
  3. Day Mode Operation:
    - a. Radiant Floor Heating: Maintain constant floor temperature set point for RHZ-11 thru RHZ-19 as sensed by separate slab temperature sensors to maintain museum exhibit zone temperature (as sensed by dedicated wall mounted thermostat) to 68 Deg F (adjustable) with AHU-6 ventilation system shut off. Reset slab temperature set point based on outside air temperature. See Hydronic Slab Heating.
    - b. Heating Mode: Modulate the VAV terminal unit reheat coil control valve(s) as required to add “trim heat” to control zone temperature to 70 Deg F plus or minus two (2)-degrees F (adjustable).
    - c. Cooling Mode: Provide constant volume supply air to each cooling zone. Reheat coil hydronic control valves remain shut.
  4. Night Mode Operation (Optional):
    - a. Ventilation system remains off. Shifts to Day mode operation if zone relative humidity fails outside control range ( $45\% \pm 8\%$ ) or temperature fails outside control range ( $70 \text{ Deg F} \pm 4 \text{ Deg F}$ ).
    - b. Radiant Floor Heating: Operation similar to Day Mode.

### 3.10 AHU-4 READING/RESEARCH/ADMIN VENTILATION SYSTEM OPERATION

- A. Ventilation System Operation:
  1. Full Shutdown Mode:
    - a. Dedicated Outside Air Unit (DOA-4):
      - 1). DOA-4 off and intake and exhaust dampers shut
    - b. Supply Fans:
      - 1). Supply fans off.
      - 2). Heating coil (HC-4) hydronic control valve shut.
      - 3). Cooling coil (C-4) control valve shut.
      - 4). Humidification system (H-4) off.
    - c. Hydronic Heating System:
      - 1). See hydronic heating system sequence of operations.
    - d. Cooling System:
      - 1). See well water cooling system sequence of operations.
    - e. Humidification System
      - 1). See humidification system sequence of operations.
  2. Air-Handler Start Sequence:
    - a. AHU-4 system runs continuously during Day Mode operation and is shut off during Night Mode operation. Provide independent, adjustable, automatic start/stop sequence for air-handling system based on time-of-day schedule initially set for Day Mode = 7 AM, Night Mode = 6 PM or as directed by The Department.
  3. Supply Fan Speed Control:
    - a. Locate duct static pressure sensors in main supply air duct, approximately 3/4 the distance between the AHU supply outlet and most remote zone variable air volume (VAV) terminal unit branch duct connection. If multiple supply air duct branches exist, provide a separate static pressure sensor in each main branch duct, located

- approximately 3/4 of the distance between the AHU supply outlet and the most remote zone terminal unit branch connections.
- b. Compare branch duct pressure readings and control supply fan speed, through the variable speed drive (VSD) controller, to maintain the lowest branch pressure at 1.5 in WC set point pressure (adjustable).
- c. If one supply fan VSD controller fails, stop associated supply fan and shut its dedicated two-position supply fan inlet damper (to prevent local recirculation air flow of the operating fans). Send "AHU-4 – Supply Fan 1" thru "AHU-4 – Supply Fan 4" trouble alarm as applicable to the BAS.
- d. If all supply fans fail, shift to Full Shutdown Mode and send "AHU-4 – System Shutdown" trouble alarm to the BAS.
- 4. Dedicated Outside Air Unit (DOA-4):
  - a. Allow AHU-4 system to recirculate the zone air volume for 30 minutes before starting DOA-4. Start DOA-4 utilizing packaged controls and operate with a 30 minute delayed start (adjustable) whenever AHU-4 system is operating.
  - b. Adjust and balance DOA-4 supply and exhaust fan VSD controllers for air intake and exhaust air flow rates as scheduled (See scheduled IAQ Documentation (M004)) to maintain the zone at a neutral building pressure relative to ambient.
  - c. Modulate electric preheat coil (PHC-4) to limit enthalpy wheel inlet temperature to no less than 10 Deg F. Bypass PHC-4 when outside air temperature is greater than 10 Deg F.
  - d. Utilize the DOA-4 packaged controls to modulate desiccant wheel face/bypass dampers and desiccant regeneration rate to control the moisture addition/removal rate to the AHU-4 system utilizing a return duct mounted relative humidity sensor.
- 5. AHU-4 Humidity and Temperature Control:
  - a. Outside air is "pre-conditioned" by DOA-4 and provides a percentage of fresh outside air ventilation utilizing a "feed and bleed" process.
  - b. Measure relative humidity using a common return duct mounted relative humidity sensor.
  - c. Measure air recirculation temperature using a duct averaging flexible sensor mounted across the AHU-4 inlet plenum.
  - d. Modulate heating coil hydronic control valve to maintain fifty-five (55) degree supply air set point temperature (adjustable) measured downstream of the supply fan.
  - e. If supply air temperature exceeds heating set point, shut heating coil (HC-4) control valve and modulate coiling coil (CC-4) hydronic control valve to supply air temperature to set point.
  - f. Control system relative humidity utilizing DOA-4 packaged controls and return duct mounted relative humidity sensor to maintain 35% RH minus 5% (adjustable).
  - g. If minimum relative humidity set point cannot be maintained modulate humidification system (H-4) to maintain zone minimum relative humidity to 30% minimum (adjustable).
- 6. Relative Humidity Monitoring;
  - a. Provide wall mounted relative humidity sensors with local Temp/RH display at the locations shown. Provide remote monitoring of the sensors from the BAS and the ability to utilize the sensors as RH control points if desired.
- B. Constant Volume Relative Humidity/Temperature Control with Auxiliary Radiant Floor Heating (First Floor Zones Only):
  - 1. AHU-4 VAV terminal units operate in constant volume (CV) mode.
  - 2. Zone Sensors:
    - a. Zone Thermostat: Provide wall-mounted zone thermostats with input to applicable zone VAV terminal equipment controllers.
    - b. Provide separate slab floor temperature sensors for radiant floor zones (RHZ- 2 thru 5 and RHZ- 7 thru 10). See Section 23 83 00 – Radiant Floor Heating Equipment.

3. Day Mode Operation:
    - a. Radiant Floor Heating: Maintain constant floor temperature set point for RHZ-2 thru RHZ-5 and RHZ- 7 thru 10) as sensed by separate slab temperature sensors to maintain first floor administration area zone temperature (as sensed by dedicated wall mounted thermostats) to 68 Deg F (adjustable) with AHU-4 ventilation system shut off. Reset slab temperature set point based on outside air temperature. See Hydronic Slab Heating.
    - b. Heating Mode: Modulate VAV terminal unit reheat coil control valve(s) as required to add "trim heat" to control zone temperature to 70 Deg F  $\pm$  2 Deg F (adjustable).
    - c. Cooling Mode: Provide constant volume supply air to each cooling zone. Reheat coil hydronic control valves remain shut.
  4. Night Mode Operation (Optional):
    - a. Ventilation system remains off. Ventilation system shifts to Day Mode operation if zone relative humidity fails outside control range (30% to 60%) or temperature fails outside control range (70 Deg F  $\pm$  2 Deg F).
    - b. Radiant Floor Heating: Operation similar to Day Mode.
- C. Constant Volume Relative Humidity/Temperature Control with Reheat and Auxiliary Perimeter Fin Tube Heating (Second Floor Zones Only):
1. AHU-4 VAV terminal units operate in constant volume (CV) mode.
  2. Zone Sensors:
    - a. Zone Thermostats: Provide wall-mounted zone thermostats with input to applicable zone VAV terminal equipment controllers.
  3. Day Mode Operation:
    - a. Heating Mode: Modulate VAV terminal unit reheat coil control valve(s) as required to add "trim heat" to control zone temperature to 70 Deg F  $\pm$  2 Deg F (adjustable). For perimeter zones with fin tube auxiliary heat, modulate reheat coil and fintube control valves in parallel.
    - b. Cooling Mode: Provide constant volume supply air to each cooling zone. Reheat coil hydronic control valves remain shut.
  4. Night Mode Operation:
    - a. Ventilation system remains off. Shift to Day Mode operation if zone relative humidity fails outside control range (30% to 60%) or temperature fails outside control range (70 Deg F  $\pm$  2 Deg F).

### **3.11 AHU-5 LOBBY/ADMIN/TECH SUPPORT VENTILATION SYSTEM OPERATION**

- A. Ventilation System Operation:
1. Full Shutdown Mode:
    - a. Dedicated Outside Air Unit (DOA-5):
      - 1). DOA-5 off and intake and exhaust dampers shut
    - b. Supply Fans:
      - 1). Supply fans off.
      - 2). Heating coil (HC-5) hydronic control valve shut.
      - 3). Cooling coil (C-5) control valve shut.
      - 4). Humidification system (H-5) off.
    - c. Hydronic Heating System:
      - 1). See hydronic heating system sequence of operations.
    - d. Cooling System:
      - 1). See well water cooling system sequence of operations.
    - e. Humidification System
      - 1). See humidification system sequence of operations.
  2. Air-Handler Start Sequence:
    - a. AHU-5 system runs continuously during Day Mode operation and is shut off during Night Mode operation. Provide independent, adjustable, automatic start/stop

- sequence for air-handling system based on time-of-day schedule initially set for Day Mode = 7 AM, Night Mode = 6 PM or as directed by The Department.
3. Supply Fan Speed Control:
    - a. Locate duct static pressure sensors in main supply air duct, approximately 3/4 the distance between the AHU supply outlet and most remote zone variable air volume (VAV) terminal unit branch duct connection. If multiple supply air duct branches exist, provide a separate static pressure sensor in each main branch duct, located approximately 3/4 of the distance between the AHU supply outlet and the most remote zone terminal unit branch connections.
    - b. Compare branch duct pressure readings and control supply fan speed, through the variable speed drive (VSD) controller, to maintain the lowest branch pressure at 1.5 in WC set point pressure (adjustable).
    - c. If one supply fan VSD controller fails, stop associated supply fan and shut its dedicated two-position supply fan inlet damper (to prevent local recirculation air flow of the operating fans). Send "AHU-5 – Supply Fan 1" thru "AHU-5 – Supply Fan 4" trouble alarm as applicable to the BAS.
    - d. If all supply fans fail, shift to Full Shutdown Mode and send "AHU-5 – System Shutdown" trouble alarm to the BAS.
  4. Dedicated Outside Air Unit (DOA-4):
    - a. Allow AHU-5 system to recirculate the zone air volume for 30 minutes before starting DOA-4. Start DOA-4 utilizing packaged controls and operate with a 30 minute delayed start (adjustable) whenever AHU-5 system is operating.
    - b. Adjust and balance DOA-5 supply and exhaust fan VSD controllers for air intake and exhaust air flow rates as scheduled (See scheduled IAQ Documentation (M004)) to maintain the zone at a neutral building pressure relative to ambient.
    - c. Modulate electric preheat coil (PHC-5) to limit enthalpy wheel inlet temperature to no less than 10 Deg F. Bypass PHC-5 when outside air temperature is greater than 10 Deg F.
    - d. Utilize the DOA-5 packaged controls to modulate desiccant wheel face/bypass dampers and desiccant regeneration rate to control the moisture addition/removal rate to the AHU-5 system utilizing a return duct mounted relative humidity sensor.
  5. AHU-5 Humidity and Temperature Control:
    - a. Outside air is "pre-conditioned" by DOA-5 and provides a percentage of fresh outside air ventilation utilizing a "feed and bleed" process.
    - b. Measure relative humidity using a common return duct mounted relative humidity sensor.
    - c. Measure air recirculation temperature using a duct averaging flexible sensor mounted across the AHU-5 inlet plenum.
    - d. Modulate heating coil hydronic control valve to maintain fifty-five (55) degree supply air set point temperature (adjustable) measured downstream of the supply fan.
    - e. If supply air temperature exceeds heating set point, shut heating coil (HC-4) control valve and modulate coiling coil (CC-5) hydronic control valve to supply air temperature to set point.
    - f. Control system relative humidity utilizing DOA-5 packaged controls and return duct mounted relative humidity sensor to maintain 35% RH minus 5% (adjustable).
    - g. If minimum relative humidity set point cannot be maintained modulate humidification system (H-5) to maintain zone minimum relative humidity to 30% minimum (adjustable).
  6. Relative Humidity Monitoring;
    - a. Provide wall mounted relative humidity sensors with local Temp/RH display at the locations shown. Provide remote monitoring of the sensors from the BAS and the ability to utilize the sensors as RH control points if desired.
- B. Constant Volume Relative Humidity/Temperature Control with Reheat and Auxiliary Perimeter Fin Tube Heating:
1. AHU-5 VAV terminal units operate in constant volume (CV) mode.

2. Zone Sensors:
  - a. Zone Thermostats: Provide wall-mounted zone thermostats with input to applicable zone VAV terminal equipment controllers.
3. Day Mode Operation:
  - a. Heating Mode: Modulate VAV terminal unit reheat coil control valve(s) as required to add "trim heat" to control zone temperature to 70 Deg F  $\pm$  2 Deg F (adjustable). For perimeter zones with fin tube auxiliary heat, modulate reheat coil and fintube control valves in parallel.
  - b. Cooling Mode: Provide constant volume supply air to each cooling zone. Reheat coil hydronic control valves remain shut.
4. Night Mode Operation:
  - a. Ventilation system remains off. Shift to Day Mode operation if zone relative humidity fails outside control range (30% to 60%) or temperature fails outside control range (70 Deg F  $\pm$  2 Deg F).

### 3.12 AHU-6 LABORATORY VENTILATION SYSTEM OPERATION

- A. Ventilation System Operation:
  1. Full Shutdown Mode:
    - a. Supply Fans:
      - 1). Supply fans off and dedicated inlet dampers shut.
      - 2). Outside air intake damper shut.
      - 3). Preheat coil (PHC-6) and heating coil (HC-6) hydronic control valves shut.
      - 4). Cooling coil (CC-6) control valve shut and booster chiller (CH-1) system off.
      - 5). Humidification system (H-6) off.
    - b. Exhaust Fans:
      - 1). Exhaust fans off and dedicated inlet dampers shut.
      - 2). Exhaust fan discharge damper shut.
    - c. Hydronic Heating System:
      - 1). Secondary Glycol Loop (PHC-6HC-6) circulator pumps (PMP-7A/7B) off and PHC-6 and HC-6 hydronic control valves open (full heat position).
      - 2). Heat Exchanger (HX-1) control valve open to minimum flow 10% open position (adjustable).
    - d. Cooling System:
      - 1). Booster chiller (CH-1) and evaporator and condenser circulator pumps (PMP-19 and PMP-20) off.
      - 2). See well water cooling system sequence of operations.
    - e. Humidification System
      - 1). See humidification system sequence of operations.
  2. Air-Handler Start Sequence:
    - a. Provide independent, adjustable, automatic start/stop sequence for air-handling system based on time-of-day schedule.
    - b. Provide a minimum five (5)-second time delay (adjustable) between the start of air handler supply fan and exhaust fan.
  3. Supply Fan Speed Control:
    - a. Locate duct static pressure sensors in main supply air duct, approximately 3/4 the distance between the AHU supply outlet and most remote zone variable air volume (VAV) terminal unit branch duct connection. If multiple supply air duct branches exist, provide a separate static pressure sensor in each main branch duct, located approximately 3/4 of the distance between the AHU supply outlet and the most remote zone terminal unit branch connections.
    - b. Compare branch duct pressure readings and control supply fan speed, through the variable speed drive (VSD) controller, to maintain the lowest branch pressure at 1.5 inch W.C. set point pressure (adjustable).
    - c. If one supply fan VSD controller fails, stop associated supply fan and shut its dedicated two-position supply fan inlet damper (to prevent local recirculation air flow

- of the operating fan). Send "AHU-6 – Supply Fan 1" or "AHU-6 – Supply Fan 2" trouble alarm as applicable to the BAS.
- d. If both supply fans fail, shift to Full Shutdown Mode and send "AHU-6 – System Shutdown" trouble alarm to the BAS.
- 4. Exhaust Fan Speed Control:
  - a. Locate exhaust air flow station in common exhaust air duct.
  - b. Control exhaust fan speed, through the variable speed drive (VSD) controller, to maintain exhaust duct pressure at -1.5 inch W.C. set point pressure (adjustable).
  - c. If one exhaust fan VSD controller fails, stop associated exhaust fan and shut its dedicated two-position exhaust fan inlet damper (to prevent local recirculation air flow of the operating fan). Send "AHU-6 – Exhaust Fan 1" or "AHU-6 – Exhaust Fan 2" trouble alarm as applicable to the BAS.
  - d. If both exhaust fans fail, shift to Full Shutdown Mode and send "AHU-6 – System Shutdown" trouble alarm to the BAS.
- 5. AHU Humidity and Temperature Control:
  - a. System operates utilizing 100% outside air.
  - b. Measure outside air intake temperature using duct averaging flexible sensors.
  - c. Modulate preheat coil hydronic control valve to maintain minimum rated enthalpy wheel inlet temperature (adjustable) measured downstream of the pre-heat coil.
  - d. Operate enthalpy wheel whenever AHU-6 is running.
  - e. Modulate coiling coil hydronic control valve to cool/dehumidify supply air to maintain laboratory zone maximum relative humidity to 45 % (adjustable).
  - f. Modulate heating coil hydronic control valve to reheat supply air downstream of cooling coil to maintain fifty-five (55) degree supply air set point temperature (adjustable) measured downstream of the supply fan.
  - g. Modulate humidification system to maintain laboratory zone minimum relative humidity to 40% (adjustable).
- B. Constant Volume Relative Humidity/Temperature Control with Auxiliary Radiant Floor Heating:
  - 1. AHU-6 VAV terminal units operate in constant volume (CV) mode. Terminal unit flow rates are adjusted and set to maintain zone-to-zone differential pressure. See Environmental Map (M401)
  - 2. Zone Sensors:
    - a. Zone Humidistat: Provide wall-mounted zone Humidistat with input to central humidifier (H-6) packaged controller and AHU-6 cooling coil (CC-6) control.
    - b. Zone Thermostat: Provide wall-mounted zone thermostats with input to applicable zone VAV terminal equipment controllers.
    - c. Provide separate slab floor temperature sensor for (RHZ-6). See Section 23 83 00 – Radiant Floor Heating Equipment.
  - 3. Day Mode Operation:
    - a. Radiant Floor Heating: Maintain constant floor temperature as sensed by slab temperature sensor to maintain laboratory suite temperature (as sensed by dedicated wall mounted thermostat) to 68 Deg F (adjustable) with AHU-6 ventilation system shut off. Reset slab temperature set point based on outside air temperature. See Hydronic Slab Heating.
    - b. Heating Mode: Modulate the VAV terminal unit reheat coil control valve(s) as required to add "trim heat" to control zone temperature to 70 Deg F plus or minus two (2)-degrees F (adjustable).
    - c. Cooling Mode: Provide constant volume supply air to each cooling zone. Reheat coil hydronic control valves remain shut.
  - 4. Night Mode Operation (Optional):
    - a. Ventilation system remains off. Shifts to Day mode operation if zone relative humidity fails outside control range (45%  $\pm$  8%) or temperature fails outside control range (70 Deg F  $\pm$  4 Deg F).
    - b. Radiant Floor Heating: Operation similar to Day Mode.

- C. Zone Pressure Control:
  - 1. Provide constant volume exhaust air flow rates in each zone as scheduled to maintain design air changes per hour.
  - 2. Utilize zone room controllers to modulate fume hood (FH), snorkel (SKL) and general exhaust air valves to maintain scheduled exhaust rates. Modulate supply air VAV terminal flow rates with offsets to maintain relative pressure requirements.
  - 3. See Environmental Map (M401) for offset and air flow direction requirements.

### 3.13 VENTILATION SYSTEM SAFETY SHUTDOWNS, MONITORING AND ALARMS

- A. Safety Shutdowns:
  - 1. General:
    - a. "Hardwire" system safety shutdowns to provide safe, reliable operation in the event of Building Automation System (BAS) failure.
    - b. Where equipment is provided with packaged stand-alone controls, capable of operating the equipment independently from the BAS, provide control logic which shifts the equipment to stand-alone (packaged control) operation in the event of BAS failure.
    - c. Do not allow supply and exhaust fans to operate independently other than for the initial 5 second fan start time delay as excessive positive or negative building pressures could result and damage the building envelope.
  - 2. Supply Duct Smoke Detector Shutdown:
    - a. Hardwire supply-duct smoke detectors directly to the building's fire alarm panel. Refer to Section 28 31 13 – Addressable Fire Alarm System for sequence of operation.
    - b. Monitor fire alarm panel "General Alarm" status from BAS system.
    - c. On "General Alarm" from fire alarm panel, shift to Full Shutdown Mode and send "AHU-1 – System Shutdown" thru "AHU-6 – System Shutdown" trouble alarms to the BAS.
  - 3. High Duct Static Pressure Shutdown:
    - a. If ventilating system duct supply static pressure increases to 3.0 inches W.C. (adjustable):
      - 1). Command the applicable ventilating system to Full Shutdown Mode.
      - 2). Provide "AHU-X High Static Pressure" alarm.
      - 3). Provide BAS software reset to reinitiate AHU-X ventilation system restart sequence.
  - 4. Low Duct Static Pressure Shutdown:
    - a. If ventilating system exhaust duct static pressure decreases to - 3.0 inches W.C. (adjustable):
      - 1). Command the applicable ventilating system to Full Shutdown Mode.
      - 2). Provide "EFU-X High Negative Static Pressure" alarm.
      - 3). Provide BAS software reset to reinitiate AHU-X/EFU-X ventilation system restart sequence.
  - 5. Low Temperature Shutdown:
    - a. If supply air temperature decreases to forty-five (45) degrees F. (adjustable):
      - 1). Place ventilating system in Full Shutdown Mode.
      - 2). Provide "AHU-X Low Temperature Shutdown" alarm.
      - 3). Provide BAS software reset to reinitiate AHU-X ventilation system restart sequence.
- B. Monitoring and Alarms:
  - 1. Air filter replacement monitoring:
    - a. Provide analog differential pressure sensor at each filter bank.
      - 1). Pre- filter and dusting filter (Farr 30/30 (MERV 8)) differential pressure range is 0.27 in WC (clean) to 1.00 in WC (dirty) at 500 feet per minute.

- 2). Generate "AHU-X High Pre-Filter Differential Pressure" maintenance alarm at 0.75 in WC (adjustable).
- b. Provide analog differential pressure sensor at each final filter bank.
  - 1). Final filter (Farr Riga-Flo (MERV 14 differential pressure range is 0.50 in WC (clean) to 1.50 in WC (dirty).
  - 2). Generate "AHU-X High Filter Differential Pressure" maintenance alarm at 1.00 in WC (adjustable).
- c. Provide analog differential pressure sensor at each carbon filter bank.
  - 1). Final filter (Farr CAMSORB CF4A differential pressure to exceed 0.34 in WC).
  - 2). Generate "AHU-X High Filter Differential Pressure" maintenance alarm at 0.34 in WC (adjustable).
- d. Zone Relative Humidity/Temperature Monitoring:
  - 1). Generate "AHU-X Zone Relative Humidity/Temperature High/Low" maintenance alarm if any zone relative humidity or temperature is not being maintained within set point band tolerance as described in Day Mode and Night Mode sequences.
  - 2). During optimized start period, generate "AHU-X Zone Temperature High/Low" maintenance alarm if any zone temperature fails to meet day temperature set point.
  - 3). Generate "AHU-X Zone Low Temperature" critical alarm if any zone temperature falls below 55 degrees F. (adjustable).
- e. Enthalpy Wheel Failure
  - 1). Operate enthalpy wheel utilizing a dedicated variable speed drive controller whenever AHU-6 is running for maximum energy recovery.
  - 2). Generate "AHU-6 Enthalpy Wheel VSD Fault" alarm if the VSD fan motor controller goes into fault.
- f. Duct Static Pressure Monitoring:
  - 1). Generate "Duct Static Pressure High/Low" maintenance alarm if duct pressure falls outside set point tolerance, plus or minus 0.05 in WC. (adjustable).
  - 2). Provide three-minute alarm time delay (adjustable) to prevent spurious alarms.
- g. AHU Flow Monitoring:
  - 1). Provide BAS monitoring of VSD enable/disable contacts, analog speed controller, and trouble contacts.
  - 2). Generate "VSD Fault" alarm if the VSD fan motor controller goes into fault.

### 3.14 SHOP VENTILATION SYSTEM OPERATION (SCF-1A/1B)

- A. General:
  - 1). The shop ventilation system utilizes a dedicated 100% outside industrial ventilation system with no recirculation to areas served by the central ventilation systems. Shop temperature is maintained continuously with a radiant floor heating system. Ventilation is only provided when the shop is occupied during the day as sensed with motion sensors to conserve energy.
  - 2). The system also serves as the make-up air system for the saw dust collection system and the paint booth. The system is designed such that both the paint booth and saw dust collection system cannot be operated at the same time.
- B. Ventilation System Operation:
  - 1). Shutdown Mode:
    - a. Supply Fans:
      - 1). Supply fan SCF-1A off and outside air intake damper shut.
      - 2). Supply fan SCF-1B and outside air intake damper shut.
    - b. Exhaust Fans:
      - 1). General exhaust fan (EF-1) and back draft damper shut.
      - 2). Paint Booth (PB-1) exhaust fan (EF-2) off.
      - 3). Welding Hood exhaust fan (EF-3) off.

- 4). Saw Dust Collector (DC-1) off.
  - c. Hydronic Heating System:
    - 1). Secondary Glycol Loop (HC-7A/7B) circulator pump (PMP-8) off and HC-7A and HC-7B hydronic control valves open (full heat position).
    - 2). Heat Exchanger (HX-2) control valve open to minimum flow 10% open position (adjustable).
  - d. Radiant Floor Heating: Maintain constant floor temperature as sensed by slab temperature sensor to maintain shop zone (as sensed by dedicated wall mounted thermostat) at 70 Deg F (adjustable) with SCF-1A and SCF-1B ventilation systems off. Reset slab temperature set point based on outside air temperature to maintain zone temperature set point. See Hydronic Slab Heating.
2. SCF-1 (Day Mode):
    - a. Operate shop ventilation system in Shutdown Mode unless occupancy is sensed by motion sensor(s).
    - b. When motion is sensed, start heating coil (HC-7A) hydronic heating pump (PMP-8).
    - c. Provide 15 second time delay (adjustable) before starting SCF-1A.
    - d. Start SCF-1A, general exhaust fan EF-1 and welding hood exhaust fan (EF-3).
    - e. SCF-1A operates at constant volume (CV) with EF-1 and EF-3 exhaust air flows manually balanced to maintain zone-to-zone differential pressure. See Environmental Map (M401).
    - f. Provide 15 minute minimum run time (adjustable) and 5 minute minimum stop time (adjustable).
  3. Temperature Control with Auxiliary Radiant Floor Heating:
    - a. Temperature Sensors:
      - 1). Provide SCF-1A supply air temperature sensor in SCF-1A supply air discharge duct.
      - 2). Provide separate slab floor temperature sensor for (RHZ-1). See Section 23 83 00 – Radiant Floor Heating Equipment.
    - b. Heating Mode:
      - 1). When SCF-1A is running, modulate SCF-1A heating coil (HC-7A) hydronic control valve to provide “trim heat” to control zone temperature to 72 Deg F  $\pm$  2 Deg F (adjustable).
      - 2). Operate radiant floor heating same as in Shutdown Mode.
  4. Saw Dust Collection System Operation
    - a. Initial conditions: SCF-1 system operation is in Day Mode (Occupied) with SCF-1A, EF-1 and EF-3 running and SCF-1B off.
    - b. Start DC-1. General exhaust fan (EF-1) stops (electrically interlocked with DC-1) and its back draft damper shuts. DC-1 and EF-1 exhaust air flow rates are matched (as scheduled) such that zone differential pressure is maintained.
    - c. Stop DC-1. EF-1 starts and its back draft damper opens.
  5. Paint Booth Operation
    - a. Initial conditions: SCF-1 system operation is in Day Mode (Occupied) with SCF-1A, EF-1 and EF-3 running and SCF-1B off.
    - b. Electronically interlock DC-1 and EF-2 such that both units cannot operate at the same time. **Saw dust collection system and paint booth operation cannot occur at the same time.**
    - c. Start PB-1 system (EF-2):
      - 1). SCF-1B outside air damper opens. When OSA damper is fully open (as sensed by limit switch), general exhaust fan (EF-1) stops (electrically interlocked with limit switch) and its back draft damper shuts. SCF-1B starts.
      - 2). SCF-1A/SCF-1B supply and EF-2/EF-3 exhaust airflow rates are matched such that zone differential pressure is maintained.
      - 3). Modulate SCF-1B heating coil (HC-7B) hydronic control valve to provide “tempering heat” to control SCF-1B supply air discharge temperature to room set point temperature (72 Deg F  $\pm$  2 Deg F (adjustable).

- d. Stop PB-1 (EF-2). SCF-1B stops and its outside air damper shuts. EF-1 starts and its back draft damper opens.
- 6. Night Mode Operation:
  - a. Same as Shutdown Mode.
- C. Low temperature shutdown:
  - 1. Stop SCF-1A/1B fans and shut outside air intake dampers if SCF-1A/1B fan discharge supply temperature is less than forty-five (45) degrees F. (adjustable).
  - 2. Provide "SCF-1A/1B Low Temperature" alarm to BAS.
  - 3. Provide BAS software reset to initiate system restart sequence.
  - 4. Minimum run timer: Provide ten (10) minute minimum system run time and five (5) minute minimum system off time (adjustable).
- D. Smoke detector shutdown: Send signal to Fire Alarm system and shutdown SCF-1A/1B on the detection of smoke.
- E. Filter Monitoring:
  - 1. Provide an analog differential pressure sensor across each SCF filter bank.
    - a. Normal filter (Camfil Farr 30/30 (MERV 8)) differential pressure range is 0.28 inWC (clean) to 0.90 inWC (dirty) at 500 feet per minute.
    - b. Generate a "SCF-1A/1B - High Filter Differential Pressure" alarm if the SCF-1A filter bank differential pressure reaches 0.80 inWC (adjustable).
    - c. Provide a similar filter monitoring alarm for SCF-1B.
- F. Fan Monitoring:
  - 1. Monitor SCF-1A supply fan motor current and generate a "SCF-1A – Fan Failure" alarm if the SCF-1A fan fails to start (or stop) when commanded "On" (or "OFF") by the BAS.
  - 2. Provide a similar fan monitoring alarm for SCF-1B.

### 3.15 BOILER 121 AND ELECTRICAL ROOM 122/123 VENTILATION SYSTEMS (SCF-2/3)

- A. Description: These separate and similar dedicated ventilation systems (SCF-2 and SCF-3) provide economizer cooling for the boiler and main electrical rooms respectively. The systems are identical and include an outside air intake louver (common to both SCFs), mixing box (with outside air and recirculation air dampers), medium efficiency filter (MERV 8) and fan sections. Excess air from the SCF-2/3 ventilation systems is relieved through associated relief air wall louvers with "cold air dams" outside the building. The boiler room relief louver assembly also serves as the combustion air opening for the fuel oil fired boilers.
- B. Zone thermostat:
  - 1. Provide wall mounted thermostat with output signal to BAS system.
- C. Cooling mode:
  - 1. Start fan SCF-2/3 when boiler room/electrical room temperature increases above seventy (72) degrees F (adjustable) set point temperature.
  - 2. Modulate mechanically linked mixing box outside air and return air dampers to maintain 55 degrees F. supply-air discharge temperature.
  - 3. When room temperature falls below seventy (70) degrees F (adjustable), stop SCF-2/3. Shut outside air damper and fully open return air damper.
- D. Heating mode:
  - 1. Shut mixing box outside air intake damper and fully open return air damper. Stop SCF-2/3.
  - 2. Heat associated zones utilizing hydronic unit heaters.
- E. Low temperature shutdown:
  - 1. Stop SCF-2/3 fan. Shut mixing box outside air intake damper and fully open return air damper if SCF discharge supply temperature is less than forty-five (45) degrees F. (adjustable).
  - 2. Provide "SCF-2/3 Low Temperature" alarm to BAS.
  - 3. Provide BAS software reset to initiate system restart sequence.

4. Minimum run timer: Provide ten (10) minute minimum system run time and five (5) minute minimum system off time (adjustable).
- F. Smoke detector shutdown: Not required for fans smaller than 2,000 CFM.
- G. Filter Monitoring:
  1. Provide an analog differential pressure sensor across each SCF filter bank.
    - a. Normal filter (Camfil Farr 30/30 (MERV 8)) differential pressure range is 0.28 inWC (clean) to 0.90 inWC (dirty) at 500 feet per minute.
    - b. Generate a "SCF-2 - High Filter Differential Pressure" alarm if the SCF-2 filter bank differential pressure reaches 0.80 inWC (adjustable).
    - c. Provide a similar filter monitoring alarm for SCF-3.
- H. Fan Monitoring:
  1. Monitor SCF-2 supply fan motor current and generate a "SCF-2 – Fan Failure" alarm if the SCF-2 fan fails to start (or stop) when commanded "On" (or "OFF") by the BAS.
  2. Provide a similar fan monitoring alarm for SCF-3.

### **3.16 ELECTRICAL ROOM COOLING FANS (TF-1 THRU 3 AND TF-5 THRU TF-7)**

- A. Transfer fans remove the heat generated from their dedicated spaces (from the installed electrical equipment heating load) to the common return air plenum. Transfer fans are used in spaces with minimal heating loads that do not warrant a dedicated air-conditioning system.
- B. Zone thermostat: Provide wall mounted thermostat with output signal to BAS.
- C. Cooling mode:
  1. Start fan transfer fan when associated room temperature increases above seventy (75) degrees F (adjustable) set point temperature.
  2. When temperature falls below seventy (70) degrees F (adjustable), stop transfer fan.
  3. Minimum run timer: Provide ten (10) minute minimum system run time and five (5) minute minimum system off time (adjustable).
- D. Fan Monitoring:
  1. Monitor transfer fan motor current and generate a "TF-1 - Fan Failure" alarm if the TF-1 fan fails to start (or stop) when commanded "On" (or "OFF") by the BAS.
  2. Provide a similar fan monitoring alarm for TF-2,3,4,5,6 and 7).

### **3.17 TELECOM ROOM 118 COOLING FAN (TF-4)**

- A. Transfer fan TF-4 provides minimum ventilating air to Telecom Room 118 which is served by dedicated computer room air-conditioning units (CRACs).
- B. Operating Mode:
  1. Start transfer fan when ventilation system AHU-5 is operating.
  2. Stop transfer fan when ventilation system AHU-5 is commanded off.
  3. Minimum run timer: Provide ten (10) minute minimum system run time and five (5) minute minimum system off time (adjustable).
- C. Fan Monitoring:
  1. Monitor transfer fan motor current and generate a "TF-4 - Fan Failure" alarm if the TF-4 fan fails to start (or stop) when commanded "On" (or "OFF") by the BAS.

### **3.18 PARKING GARAGE RELIEF FANS (RF-1 THRU RF-3)**

- A. Enable parking garage lead relief fan (RF-1, RF-2 or RF-3) to operate intermittently on the detection of vehicle or pedestrian movement utilizing an approved automatic motion detection device (See Electrical). Rotate lead relief fan daily (at 24 hour intervals) to equalize relief fan wear.
- B. Monitor carbon monoxide (CO) concentration at three (3) separate locations within the parking garage as shown. Start lead relief fan as required to maintain CO concentration below 35

PPM (adjustable). Stop fan at a CO concentration of 30 PPM (adjustable). If CO concentration cannot be reduced below set point within 5 minutes (adjustable), start the next relief fan in sequence. If an additional 5 minutes elapses and CO concentration has still not been reduced below set point, start the third relief fan and provide a "Parking Garage High CO Level" alarm to BAS.

### 3.19 VESTIBULE 100 VENTILATION (CUH-5A AND CUH-5B)

- A. Cabinet unit heater coils "run wild."
- B. Provide manual fan control to select "Off", "Low" or "High" cabinet unit heater fan speed.
- C. Cycle CUH fans in parallel as necessary to maintain 65 Degrees F (adjustable) set point temperature utilizing 120V wall mounted thermostats.

### 3.20 HUMIDIFICATION SYSTEM

- A. General System Description: The humidification system consists of six (6) separate electric humidification units with one unit dedicated to each of the six (6) separate central air handling units.
- B. Full Shutdown Mode (Initial conditions):
  - 1. Humidifiers (H-1 thru H-6) off.
- C. Command enable/disable humidification system from the BAS to operate whenever associated central air handling system is operational.
- D. Control humidification system using the associated packaged humidifier control system to maintain zone relative humidity (RH) (adjustable).
- E. See Section 23 84 00 – Humidification Equipment for additional packaged controller specific control sequences.
- F. System Monitoring and Alarm:
  - 1. Generate a "H-1 Trouble Alarm" for any alarm condition received via the gateway from the H-1 humidification control panel to the BAS.
  - 2. Provide a similar monitoring alarm for H-2 thru H-6).

### 3.21 CENTRAL HYDRONIC HEATING SYSTEM

- A. General System Description
  - 1. The system consists of one (1) electric boiler (BLR-1) sized for 100% heating demand and two (2) fuel oil fired boilers (BLR-2 and BLR-3) each sized for 50% heating demand. The operator can select to operate with either the electric or the two (2) fuel oil boilers as the lead boilers based on local energy cost at the time.
  - 2. The three boilers are connected in parallel, each with a dedicated, constant speed primary loop circulator pump (PMP-1 thru PMP-3). Each pump is sized to provide a thirty (30) degree F differential temperature across its boiler at maximum rated thermal output.
  - 3. The primary boiler loop is connected to the secondary building heating loops using a primary-secondary loop arrangement.
  - 4. Secondary loop circulator pumps (PMP-4A/PMP-4B) circulate heating water to the AHU-1 thru AHU-4 heating coils
  - 5. Secondary loop circulator pumps (PMP-5A/PMP-5B/PMP-5C) circulate heating water to the AHU-5, secondary glycol loop heat exchangers (HX-1 and HX-2) serving AHU-6 and SCF-1A/1B heating coils receptively, the snow melt heat exchanger (HX-3) and perimeter heating units (VAV reheat coil, fin tube, radiant panel and unit heaters).
  - 6. Secondary loop circulator pumps (PMP-6A/PMP-6B) circulate reduced temperature heating water to the radiant floor heating zones.
  - 7. Secondary glycol loop circulator pumps (PMP-7A/PMP-7B) circulates 50 percent glycol solution to the air handler (AHU-6) heating coils.
  - 8. Secondary glycol loop circulator pumps (PMP-8) circulates 50 percent glycol solution to the shop small cabinet fan (SCF-1A/SCF-1B) heating coils.

9. Secondary building loop supply temperature set point is reset by the BAS based on outside air temperature.
  10. Two (2) bladder type expansion tanks maintain hydronic system pressure. Make-up water is provided by a pressure regulated connection to the service water system. A double check backflow preventer is included to protect the water source from back-flow contamination. A low pressure warning alarm indicates when hydronic heating system pressure is below set point.
  11. The central boilers and associated boiler circulator pumps are controlled and monitored by the building automation system (BAS) using the boilers packaged controls and flame safeguard systems.
- B. Central Hydronic Boiler Operation
1. Select primary heating fuel source as "Electric" or "Fuel Oil" utilizing the BAS interface panel. Set heating system default to "Fuel Oil" (adjustable).
  2. Fuel Oil Mode (Default):
    - a. Start boiler primary loop circulator pumps (PMP-2 and PMP-3). Let pumps run for five (5) minutes (adjustable) to allow temperatures to equalize.
    - b. Start lead secondary loop circulator pumps (PMP-4A and PMP-5A). Let pumps run for ten (10) minutes (adjustable) to allow temperatures to equalize.
    - c. Enable fuel oil fired boilers (BLR-2 and BLR-3) from the BAS and operate boilers using packaged boiler controls in accordance with the manufacturer's suggested operating instructions to maintain secondary loop temperature (downstream of AS-1) at 190 degrees F (adjustable).
  3. Electric Mode:
    - a. Start boiler primary loop circulator pump (PMP-1). Let pump run for five (5) minutes (adjustable) to allow temperatures to equalize.
    - b. Start lead secondary loop circulator pumps (PMP-4A and PMP-5A). Let pumps run for ten (10) minutes (adjustable) to allow temperatures to equalize.
    - c. Enable electric boiler (BLR-1) from the BAS and operate boiler using packaged boiler controls in accordance with the manufacturer's suggested operating instructions to maintain secondary loop temperature (downstream of AS-1) at 190 degrees F (adjustable).
    - d. In the event of a power outage, shift to Fuel Oil Mode.
  4. Dual Fuel Mode:
    - a. If building heating set point cannot be reached in the selected heating mode (electric heating element failure, fuel oil boiler failure or maintain), the system may be operated with both electric and fuel oil fired boilers operating simultaneously.
    - b. Select primary heating fuel source as "Dual" utilizing the BAS interface panel. Select boiler firing order Lead, Lag 1, Lag 2 (BLR-1/BLR-2/BLR-3)
    - c. Start Lead boiler primary loop circulator pump (PMP-1/PMP-2/PMP-3). Let pump run for five (5) minutes (adjustable) to allow temperatures to equalize.
    - d. Start lead secondary loop circulator pumps (PMP-4A and PMP-5A). Let pumps run for ten (10) minutes (adjustable) to allow temperatures to equalize.
    - e. Enable Lead boiler and operate boiler using packaged boiler controls in accordance with the manufacturer's suggested operating instructions to maintain secondary loop temperature (downstream of AS-1) at 190 degrees F (adjustable).
    - f. Start Lag 1 circulator pump and enable Lag 1 boiler if heating demand cannot be met with lead boiler.
    - g. Start Lag 2 circulator pump and enable Lag 2 boiler if heating demand cannot be met with Lead and Lag 1 boilers.
- C. Secondary Building Loop Variable Speed Circulator Pump Operation
1. Provide a separate hydronic system pressure sensor in each main hydronic header branch line. Locate each sensor approximately 3/4 the distance between the secondary loop circulator pumps combined discharge and the most remote terminal heating unit control valve in each loop.

2. Adjust VSD controller output to modulate pump speed between 35 percent and 100 percent flow to maintain the lowest reading hydronic header pressure sensor at set point pressure. Set initial header pressure set point to 8 PSID (adjustable).
  3. In the event of a VSD failure, the VSD automatically fails to bypass mode (pump operates at 100 percent speed in bypass mode).
  4. Secondary circulator pump operation shall normally be Lead Pump in "RUN" and Standby Pump in "STBY." Automatically shift lead pumps monthly (adjustable).
  5. For loops with three secondary circulator pumps, operate with Lead Pump in "RUN" and Standby Pumps in "STBY1" and STBY2." Automatically shift lead pumps and standby pumps monthly (adjustable).
- D. Secondary Building Loop Temperature Reset Control:
1. Monitor outside air temperature and automatically calculate required secondary loop reset supply temperature.

Hydronic System Temperature Reset Schedule

Outside Air Temperature	Secondary Loop Water Temperature Set point
60 Degrees F	140 Degrees F
0 Degrees F	190 Degrees F

- E. Secondary Building Radiant Floor Heating Loop Circulator Pump Operation
1. When outside air temperature decreases to sixty (60) degrees F. (adjustable), start lead radiant heat loop circulator pump (PMP-6A/6B).
  2. Modulate three-way temperature control valve to maintain a supply water temperature of 140 Degrees F (adjustable).
  3. In the event of a pump failure, start standby pump.
  4. Normal pump operation shall be Lead Pump (PMP-6A) in "RUN" and Standby Pump (PMP-6B) in "STBY." Automatically shift lead pump monthly (adjustable).
- F. Radiant Floor Heating
1. Description: In general, the radiant floor heating system operates to maintain a constant "baseline" floor set point temperature utilizing slab floor temperature sensors. Floor temperature is reset based on outside air temperature. Zone temperature set point is maintained by the ventilation system.
  2. System Shutdown:
    - a. Central radiant floor heating pumps (PMP-6A/6B) off.
    - b. Zone circulator pumps off.
  3. Typical System Operation:
    - a. When outside air temperature decreases to sixty (60) degrees F. (adjustable), start lead radiant heat loop circulator pump.
    - b. Start zone radiant floor zone circulator pumps.
    - c. Operate circulator pumps for one (1) hour (adjustable) to allow slab temperatures to stabilize.
    - d. After slab temperature stabilization period, measure floor slab temperature. Modulate 4-way valves to maintain scheduled floor slab temperature based on outside air temperature as follows:

Floor Slab Temperature Reset Schedule	
Outside Air Temperature	Slab Floor Temperature Set point
Greater than 60 Degrees F.	System off
60 Degrees F. to 0 Degrees F.	65 Degrees F. (adjustable)

0 Degrees F. or below.	80 Degrees F. (adjustable)
------------------------	----------------------------

- e. Limit maximum floor temperature to 85 degrees F.
- f. When outside air temperature increases to sixty-five (65) degrees F. (adjustable) and increasing, stop zone circulators and modulate control valves to full re-circulate position (minus 10%\*). \* Do not fully isolate radiant floor tubing from central radiant heating system.
- 4. Radiant Floor Heating System Monitoring and Alarm:
  - a. Provide current sensing (digital) for radiant floor circulation pump.
  - b. Generate a separate alarm if any pump fails to operate when commanded to start from the BAS.
  - c. High Temperature Alarms:
    - 1). If any zone supply temperature water exceeds 115 degrees F. (adjustable), generate a separate "Zone X High Radiant Supply Temperature" alarm.
    - 2). If any slab temperature sensor exceeds 85 degrees F. (adjustable), generate a separate "Zone X High Floor Temperature" alarm.
- G. Secondary Glycol Loop System Operation
  - 1. General: The secondary glycol loop heating systems provide freeze protection for the 100% outside air ventilation system coils (AHU-6 and SCF-1A/SCF-1B). The systems operate whenever AHU-6 and SCF-1A/SCF-1B are operating.
  - 2. AHU-6 System:
    - a. When AHU-6 supply air temperature drops below set point temperature and HC-6 control valve starts to open, start lead secondary loop circulator pump (PMP-7A). If lead pump fails to start as determined by current sensor, disable lead pump and start standby pump (PMP-7B). Modulate heating control valve to maintain supply temperature set point.
    - b. When outside air intake temperature drops below 38 Degrees F (adjustable), modulate preheat coil (PHC-6) control valve to maintain a PHC-6 discharge temperature of 38 Degrees F (adjustable).
  - 3. SCF-1A/SCF-1B System:
    - a. When an SCF-1A/SCF-1B supply temperature drops below set point temperature and HC-7A/HC-7B control valve(s) start to open, start circulator pump (PMP-8). If PMP-8 fails to start, shift SCF-1A/SCF-1B to full shutdown.
  - 4. See AHU-6 and SCF-1A/SCF-1B operating sequences for additional requirements.
- H. Provide the following hydronic system controls, monitoring and alarm points to the BAS:
  - 1. Flame Safeguard failure.
  - 2. Boiler circulator pumps trouble alarms. Provide current sensing (digital) for each pump. Generate an alarm if any pump fails to run. May be integrated with boiler manufactures boiler control panel.
  - 3. Secondary loop pump trouble alarms: Provide current sensing (digital) for each pump. Generate an alarm if pumps fail to operate in their normal run sequence.
  - 4. Hydronic system pressure: Monitor system pressure with analog sensor. Generate system pressure alarm if system pressure falls below 12 psig.
  - 5. Glycol loop pump trouble alarms: Provide current sensing (digital) for each pump. Generate an alarm if pumps fail to operate in their normal run sequence.
  - 6. Glycol loop pressure: Monitor system pressure with analog sensor. Generate system pressure alarm if system pressure falls below 12 psig.
- I. Air Handler Heating Coils
  - 1. See Ventilation Control Sequences.
- J. Zone VAV Reheat Coils
  - 1. See Ventilation Control Sequences.
- K. Zone Perimeter Fin tube and Radiant Panels
  - 1. See Ventilation Control Sequences.

- L. Parking Garage Soffit Heating
  - 1. To be issued by addendum.
- M. Clerestory Perimeter Heating
  - 1. To be issued by addendum.
- N. Marquee Heating
  - 1. To be issued by addendum.
- O. Cabinet Unit Heaters
  - 1. Cabinet unit heaters "run wild."
  - 2. Provide manual fan control to select "Off", "Low" or "High" cabinet unit heater fan speed.
  - 3. Cycle fans as necessary to maintain 65 Degrees F (adjustable) set point temperature utilizing 120V wall mounted thermostats.
  - 4. When two cabinet unit heaters are provided to heat a common space. Operate both cabinet unit heaters in parallel.
- P. Unit Heaters
  - 1. Unit heaters "run wild."
  - 2. Provide manual fan control to select "Off", "Low" or "High" unit heater fan speed.
  - 3. Cycle fans as necessary to maintain 65 Degrees F (adjustable) set point temperature utilizing 120V wall mounted thermostats.
  - 4. When two unit heaters are provided to heat a common space. Operate both cabinet unit heaters in parallel.

### **3.22 WELL WATER/CHILLED WATER COOLING SYSTEM**

- A. To be issued by addendum.

### **3.23 TELECOM ROOM COOLING SYSTEM (CRAC-1 THRU CRAC-6)**

- A. To be issued by addendum.

### **3.24 ELECTRICAL ROOM COOLING SYSTEM (SCF-4)**

- A. To be issued by addendum.

### **3.25 BOOSTER CHILLER (CH-1) COOLING SYSTEM**

- A. General System Description: The central chilled water system circulates 45 Deg F chilled water to the facilities six (6) central air handling unit hydronic cooling coils. The AHU-6 central air handling system is a 100% outside air system. Its cooling coil (CC-6) must not only cool, but must also dehumidify the incoming outside air. A booster chiller (CH-1) is used to provide additional dehumidification capability to CC-6 (reduced supply water temperature from 45Deg F to 42 Deg F (adjustable)) to properly control laboratory suite relative humidity.
- B. Full Shutdown Mode (Initial conditions):
  - 1. Booster Chiller (CH-1) off.
- C. Operating Mode:
  - 1. System Enable: Enable operation of CH-1 when AHU-6 is enabled and calling for cooling.
  - 2. Start CH-1 and associated pumps PMP-19 and PMP-20 when chilled water supply temperature to CC-6 is greater than 42 Deg F (adjustable).
  - 3. Modulate CH-1 to control chilled water supply temperature to CC-6 to 42 Deg F (adjustable).
  - 4. System Shutdown: Disable operation of CH-1 and associated pumps PMP-19 and 20 whenever AHU-6 is disabled.
- D. System Monitoring and Alarm:
  - 1. If CH-1, PMP-18 or PMP-19 fails to operate as commanded by the BAS, provide a "Booster Chiller (CH-1) BAS Alarm" to the BAS.
  - 2. Generate a "Booster Chiller (CH-1) Local Alarm" for any internal alarm condition indicated via the gateway from CH-1 to the BAS.

### 3.26 PLUMBING

- A. Domestic and Laboratory Water Heaters:
  - 1. Provide scheduled time-of-day operation for the water heaters:
    - a. WH-X Enable: 0600 (adjustable).
    - b. WH-X Disable: 2200 (adjustable).
  - 2. Provide hot water temperature sensor (analog) with remote monitoring from BAS.
  - 3. Control hot water temperature utilizing the water heaters packaged temperature control system. Set aquastat to 140 degrees F. (adjustable).
  - 4. Adjust thermal mixing valve to maintain a constant 110 Degree F (adjustable) hot water supply temperature when water heater is operating.
- B. Hot Water Circulation Pumps:
  - 1. Provide scheduled time-of-day operation for the domestic hot water recirculation pumps:
    - a. Pump start: 0600 (adjustable).
    - b. Pump stop: 2200 (adjustable).
- C. Tempered Water Heaters:
  - 1. Provide scheduled time-of-day operation for the water heaters:
    - a. WH-X Enable: 0600 (adjustable).
    - b. WH-X Disable: 2200 (adjustable).
  - 2. Provide tempered water temperature sensor (analog) with remote monitoring from BAS.
  - 3. Control tempered water temperature utilizing the water heaters packaged temperature control system. Set aquastat to 110 degrees F. (adjustable).
  - 4. Adjust thermal mixing valve to maintain a constant 85 Degree F (adjustable) tempered water supply temperature when water heater is operating.
- D. Tempered Water Circulation Pumps:
  - 1. Provide scheduled time-of-day operation for the domestic hot water recirculation pumps:
    - a. Pump start: 0600 (adjustable).
    - b. Pump stop: 2200 (adjustable).

**END OF SECTION 25 90 00**

**SECTION 26 00 00**  
**ELECTRICAL GENERAL REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION AND RELATED WORK**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.
- B. This Section applies to all Division 26, 27 and 28 Sections and is part of all other Division 26, 27 and 28 Sections.
- C. Index of Electrical Specifications:
  - 1. 26 00 00 - Electrical General Requirements
  - 2. 26 05 00 - Basic Materials and Methods
  - 3. 26 05 10 - Wire and Cable
  - 4. 26 05 29 - Hangers and Supports
  - 5. 26 05 33 - Outlet Boxes
  - 6. 26 05 34 - Conduit and Fittings
  - 7. 26 05 35 - Surface Raceways
  - 8. 26 05 36 - Cable Tray
  - 9. 26 05 37 - Pull and Junction Boxes
  - 10. 26 22 00 - Secondary Transformers
  - 11. 26 24 00 - Disconnects
  - 12. 26 24 16 - Panelboards
  - 13. 26 25 00 - Grounding
  - 14. 26 26 10 - Surge Protective Devices (SPDs)
  - 15. 26 26 20 - Overcurrent Protective Devices
  - 16. 26 26 30 - Motor Starters
  - 17. 26 26 40 - Contactors
  - 18. 26 27 26 - Wiring Devices
  - 19. 26 27 49 - Network Lighting Control System
  - 20. 26 29 13 - Distribution Switchboards
  - 21. 26 30 00 - Emergency Standby Generation System
  - 22. 26 30 04 - Automatic Transfer Switches
  - 23. 26 33 53 - Static Uninterruptible Power Supply
  - 24. 26 50 00 - Lighting Fixtures
  - 25. 26 50 10 - Lamps and Ballasts
  - 26. 27 05 24 - Digital Video Recording System
  - 27. 27 20 10 - Telecom Distribution System
  - 28. 27 20 20 - Telecom Optical Fiber Distribution
  - 29. 27 30 10 - Hearing Impaired Audio System (RF)
  - 30. 27 41 16 - Audio-Video Systems and Equipment
  - 31. 27 51 23 - Public Address System
  - 32. 28 13 33 - Security Management System
  - 33. 28 31 13 - Addressable Fire Alarm System

**1.2 SCOPE**

- A. Provide all labor, products and services required for the complete installation, checkout, and startup of all systems shown and specified.
- B. Where the work of several crafts is involved, coordinate all related work to provide each system in complete and in proper operating order.
- C. Cooperate with all others involved in the project, with due regard to their work, to promote rapid completion of the entire project.

- D. Local Conditions: The Contractor shall thoroughly familiarize himself with the work as well as the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions, and all other local conditions, which may affect the progress and quality of the work.
- E. Utility Coordination: Coordinate all work with the serving utilities (electrical, telephone, cable television, etc.) and provide equipment and installation in accordance with the respective utility requirements. Meet with the serving utilities and coordinate the installation and location of the services. Provide a written statement of approval from each serving utility. Provide trenching from telephone and television stubout locations to property line in accordance with respective utility requirements.
- F. Provide Commissioning services as specified in Division 1 and Divisions 26, 27 and 28.

### 1.3 CODES AND STANDARDS

- A. Codes: Perform all work in strict accordance with all applicable national, state and local codes; including, but not limited to the latest legally enacted editions of the following specifically noted requirements:
  - 1. NFPA 70, National Electrical Code - NEC.
  - 2. ANSI-C2, National Electrical Safety Code - NESC.
  - 3. International Building Code - IBC.
  - 4. International Fire Code - IFC.
  - 5. Underwriters Laboratory (UL) or approved equal.
- B. Standards: Reference to the following standards infers that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
  - 1. American National Standards Institute - ANSI.
  - 2. American Society for Testing and Materials - ASTM.
  - 3. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE (Standard 90-75).
  - 4. Institute of Electrical and Electronics Engineers - IEEE.
  - 5. Insulated Cable Engineers Association - ICEA.
  - 6. National Electrical Manufacturers' Association - NEMA.
  - 7. National Fire Protection Association - NFPA.

### 1.4 SPECIFICATION TERMINOLOGY

- A. "Contracting Agency" is the Department as defined in the General Conditions of the Contract.
- B. Streamlining: In many instances, the products, reference standards, and other itemized specifications have been listed without verbiage. In these cases, it is implied that the Contractor shall provide the products and perform in accordance with the references listed.
- C. "Provide" means furnish all products, labor, subcontracts, and appurtenances required and install to a complete and properly operating, finished condition.
- D. "Furnish" means to purchase material as shown and specified, and cart the material to an approved location at the site or elsewhere as noted or agreed, to be installed by supporting crafts.
- E. "Install" means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.
- F. "Rough-in and connect" means provide an appropriate system connection such as conduit with junction boxes, wiring, switches, disconnects, etc., and all wiring connections. Equipment furnished is received, uncrated, assembled, and set in place under the Division in which it is specified.
- G. "Accessible" means arranged so that an appropriately dressed man, 6 feet-2 inches tall, weighing 250 pounds, may approach the area in question with the tools and products

necessary for the work intended, and may then position himself to properly and safely perform the task to be accomplished, without disassembly or damage to the surrounding installation.

- H. "Serviceable" means arranged so that the component or product in question may be properly removed, and replaced without disassembly, destruction or damage to the surrounding installation.
- I. "Product" is a generic term, which includes materials, equipment, fixtures, and any physical item used on the project.
- J. "Basis of Design" refers to products around which the design was prepared. Some or all of the particular characteristics of Basis of Design products may be critical to the fit or performance of the completed installation. Such characteristics are often subtle. Where substitutions are made to products that are the Basis of Design, the Contractor is alerted that nominally acceptable substitutions may produce undesirable side effects such as switchboards that no longer fit the space due to increased product dimensions. The Contractor is responsible for resolving all impacts of substitutions. Approval of a substitution request does not relieve the Contractor of complying with the design intent and all Codes.
- K. "As Specified" denotes a product, system, or installation that:
  - 1. Includes all of the salient characteristics identified in the Drawings and Specifications;
  - 2. Meets all of the requirements of the "Basis of Design"; and
  - 3. Is produced by a manufacturer listed as acceptable on the Drawings or in the Specifications.
- L. "Substitution" is a product, system or installation that is not by a listed manufacturer or does not conform to all salient characteristics identified in the Contract Documents, but which the Contractor warrants meets all specific requirements listed in the Contract Documents.
- M. "System Drawing" is a diagrammatic engineered drawing that shows the interconnection and relationship between products to demonstrate how the products interact to accomplish the function intended. Examples of system drawings include control and instrumentation diagrams, and wiring diagrams. Some drawings, such as dimensioned and complete Fire Protection Drawings may be both System Drawings and Shop Drawings.
- N. "Shop Drawings" are dimensioned working construction drawings drawn to scale to show an entire area of work in sufficient detail to demonstrate service and maintenance clearances and complete coordination of all trades.
- O. Reference to a specific manufacturer's product (even as "Basis of Design") does not necessarily establish acceptability of that product without regard to compliance with all other provisions of these specifications.

### **1.5 DRAWINGS, SPECIFICATIONS AND SYMBOLS**

- A. The Drawings and specifications are complementary. Do not scale the Drawings. Locations of devices, fixtures, and equipment are approximate unless dimensioned.
- B. The Drawings are partly diagrammatic and do not show precise routing of conduits or exact location of all products, and may not show in minute detail all features of the installation; however, provide all systems complete and in proper operating order.
- C. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry. Special items are identified by a supplementary list of graphical illustrations, or called for on the Drawings or in the specifications.

### **1.6 PRODUCT AND SYSTEM SUBMITTALS**

- A. Submittals: Provide Submittals for all products and systems described in Divisions 26, 27 and 28 and shown on the Drawings to demonstrate compliance with the requirements of the project. Unless specified otherwise in Division 1, submit data not later than 60 days after award of contract or, in any case, to allow sufficient time for review without delaying

construction. Furnish equipment Submittals in the manner described elsewhere in these specifications. In addition, include data for review, and organize data, as noted below:

1. Specification reference and/or drawing reference for which literature is submitted for review with an index, following specification format, and item by item identification.
2. Manufacturer's name and address, and supplier's name, address and telephone number.
3. Catalog designation or model number.
4. Rough-in data and dimensions.
5. Operation characteristics.
6. Wiring diagrams for the specific system.
7. Coordination data to check protective devices.
8. All information required to verify compliance with the short-circuit withstand and interrupting ratings, as shown on the Drawings or further stated in these Specifications.
9. Certification that all data shown on the Drawings or further stated in these Specifications concerning available short-circuit currents has been confirmed with the serving Electric Utility.
10. Working construction drawings (shop drawings).
11. A customized listing of the characteristics identified in the Contract Documents. Indicate whether each item is submitted as "Basis of Design", "As Specified" or "Proposed Substitution". Clearly indicate on product data sheets the data which show the product meets the requirements. Indicate all deviations and mark out all non-applicable items.
12. ALL PROPOSED SUBSTITUTIONS, DEVIATIONS, MODIFICATIONS, OR CHANGES OF ANY TYPE WHATSOEVER FROM THE PRODUCTS OR SYSTEMS SPECIFIED SHALL BE CLEARLY ITEMIZED IN THE SUBMITTAL INDEX. Submittal approval will not include such deviations unless they are specifically itemized and approved. Where deviations of substitute product or system performance have not been specifically noted in the submittal by the Contractor and accepted by the Contracting Agency, provision of a complete and satisfactory working installation of equal quality to system specified is the sole responsibility of the Contractor. Unapproved deviations discovered in the field shall be corrected as directed by the Contracting Agency.
13. DELETE ALL SUPERFLUOUS INFORMATION FROM SUBMITTAL DATA SUCH AS MODEL NUMBERS AND OPTIONS FOR EQUIPMENT CONTAINED ON MANUFACTURER'S DATA SHEETS BUT NOT USED ON THIS PROJECT.
14. Submittals not completely marked as indicated above, in the opinion of the Engineer, will be rejected without review.

B. Coordination:

1. The Contractor shall create and maintain a master submittal log for all items submitted in Divisions 26, 27 and 28. Submit master submittal log with first submittal.
2. Prior to submission for approval, the Contractor shall hold a meeting of all trades to review all shop drawings and Submittals. All trades shall cross-check all shop drawings and Submittals for conflicts, clearances, physical space allocation and routing, discrepancies, dimensional errors, omissions, contradictions, departures from the Contract requirements, correct electrical/mechanical services and connections, and provisions for Commissioning.
3. The Contractor shall revise, correct, and appropriately annotate all Submittals prior to submission for approval.

C. Certificate of Coordination: Include with the Submittals a complete letter in the following format:

I \_\_\_\_\_ (Name),  
of \_\_\_\_\_ (Firm), certify that the  
meeting of all trades for coordination of shop drawings and Submittals as required by  
Specifications Section 26 00 00 - Electrical General Requirements was held on  
\_\_\_\_\_ (Dates(s)). I further certify that, except as noted on the shop drawings  
and Submittals, they are free of conflicts, discrepancies, dimensional errors, omissions,  
contradictions, and departures from the Contract requirements, and that they provide for

proper clearances, physical space allocation and routing, correct electrical/mechanical services and connections, and provisions for Commissioning.

SIGNED: \_\_\_\_\_  
DATE: \_\_\_\_\_  
TITLE: \_\_\_\_\_

- D. A current copy of all approved Submittals and the submittal log shall be kept at the job site.
- E. With prior permission from the Contracting Agency, partial Submittals will be considered for review provided that they are complete sections, as listed below:
  - 1. Individual Special Systems (Fire Alarm, Intercom, etc.)
  - 2. Switchboards, Panels and Transformers.
  - 3. Low Voltage Systems of All Types.
  - 4. Emergency Generation System.
- F. Mark submittal literature and shop drawings clearly and bind 8-1/2 by 11 inch literature in three-ring hardback loose-leaf binders by individual sets.
- G. Submittal review is for general design and arrangement only and does not relieve the CONTRACTOR from any of the requirements of the Contract Documents. Submittals will not be checked for quantity, dimension, fit or proper technical design of manufactured equipment.

#### 1.7 SHOP DRAWINGS REQUIRED

- A. The Contract Documents are not intended for nor are they suitable for use as shop drawings. Do not use Contract Drawings for direct fabrication or installation of products or equipment; instead, prepare shop drawings for installation and arrangement of work. Submit shop drawings as requested, specified, or otherwise required demonstrating proper planning for installation and arrangement of all work to the satisfaction of the Contracting Agency. Lay out drawings to scale and show dimensions where accuracy of location is necessary for coordination or communication purposes. Scale shall be appropriate to clearly show all aspects of installation and equipment arrangement. Show work of all trades, including Architectural, Structural, Mechanical, and Electrical items which are pertinent to proper and accurate coordination and conflict resolution.
- B. In all cases where one or more equipment items in a mechanical or electrical room or space differ in dimensions or configuration from Basis of Design equipment, the working drawing shall show the entire area. The drawing shall be dimensioned to indicate that required aisle ways and maintenance clearances are being maintained to at least the degree shown on the Contract Drawings.
- C. Provide shop drawings for all products, systems, system components, and special supports that are not a standard catalog product and which may be fabricated for the Contractor or by the Contractor. In addition provide shop drawings for:
  - 1. Electrical and telecommunications rooms and spaces, including all equipment. Demonstrate all required clearances and working spaces are provided.
  - 2. Routing and interdisciplinary coordination of groups of conduits numbering more than one and over two inch trade size.
  - 3. Cable Trays.
  - 4. Telecom equipment rack elevations.
  - 5. CCTV equipment rack elevations.
- D. Prepare shop drawings using the latest release of AutoCAD.
- E. Record Shop Drawings: Provide a copy of the final, corrected, approved shop drawings for the project, updated to show as-built conditions. Drawings shall indicate exact device locations and conduit and wire routing. Prepare drawings using the latest release of AutoCAD and deliver files to the Contracting Agency. Refer to other specification sections for additional system specific requirements.

## 1.8 PERMITS, TESTS AND INSPECTIONS

- A. Schedule, obtain, and pay for all permits and fees required by local authorities and by these specifications.
- B. Request for Tests: Notify the Contracting Agency a minimum of 72 hours in advance of tests. In the event the Contracting Agency does not witness the test, certify in writing that all specified tests have been made in accordance with the specifications.
- C. Deficiencies: Immediately correct all deficiencies that are evidenced during the tests and repeat tests until system is approved. Do not cover or conceal electrical installations until satisfactory tests are made and approved.
- D. Operating Tests: Upon request from the Contracting Agency, place the entire electrical installation and/or any portion thereof, in operation to demonstrate satisfactory operation.

## 1.9 IDENTIFICATION

- A. Equipment Labels and Nameplates:
  - 1. Provide rigid engraved labels and nameplates of 1/16 inch thick laminated plastic.
    - a. Label and Nameplate Colors:
      - 1). Normal Equipment: White letters on a black or gray background (engraved labels).
      - 2). Emergency Equipment: White letters on a red background.
    - b. Securely attach labels with threaded fasteners or pop-rivets. (Adhesive attachment not acceptable.)
    - c. Temporary markings not permitted on equipment. Repaint trims, housings, etc., where markings cannot be readily removed. Refinish defaced Finishes.
    - d. No labeling abbreviations will be permitted without prior approval.
  - 2. Include item designation and branch circuit designation (panel and circuit number) on Disconnects, starters, equipment and device nameplates, e.g., "FAN #4, Circuit LA-30").
  - 3. Label and Nameplate Locations:
    - a. Provide 1 inch minimum height letters on following equipment:
      - 1). Service disconnect (red background).
    - b. Provide 1/2 inch minimum height letters on following equipment:
      - 1). Secondary feeder breakers in distribution equipment. Designation as required by load served.
      - 2). Special equipment housed in cabinets, as designated on plans, on outside of door.
      - 3). Equipment housed in CCTV equipment cabinets, as designated on plans, on inside of cabinet door.
      - 4). Panelboards, switchboards, motor control centers, as designated on plans, on outside of door.
      - 5). Service equipment. Provide signage in accordance with NEC Article 110.24(A) indicating maximum available fault current and date of fault current calculation.
    - c. Provide 1/4-inch minimum height letters on:
      - 1). Disconnects and starters for motors or fixed appliances.
      - 2). Designated electrical equipment.
    - d. Provide 1/8-inch minimum height, engraved device plates on switches and receptacles where item controlled is not visible from the switch, or as noted on drawings.
    - e. Engrave branch circuit designation (panel and circuit number) on receptacle and light switch device plates, e.g., "81NPA-30"). Verify final panel designations with Contracting Agency prior to engraving nameplates.
    - f. Provide 1/8-inch minimum height letters on lighting control relays, dimmer controls and remote lighting control equipment.

- g. External Power Sources: Provide 1/8-inch white letters on red background on all starters or controllers that receive power from an external source that is not de-energized by operating the associated disconnecting means.
- B. Branch Circuit Panelboard Directories: Provide neatly typed schedule (odd numbered circuits on left side or top, even on right side or bottom) under plastic jacket or protective cover to protect the schedule from damage or dirt. Securely mount on inside face of panelboard door. Define briefly, but accurately, nature of connected load (i.e., Lighting Room 2989, Receptacles Janitor Room, Etc.) as approved. Sequentially numbered schedules shall not be used.
- C. One-Line Diagram: Provide approved print for the "As-Built" distribution system. Mount behind protective cover (1/8-inch minimum thickness clear Plexiglas) in substantial frame, in accessible location at main switchboard.
- D. Empty Conduits: Provide tags with typed description of purpose, and location of opposite end, wired to each end of conduits provided for future equipment.
- E. Conduits: Mark conduits entering or leaving Panelboards with indelible black magic marker with the circuit numbers of the circuits contained inside. Identify all Fire Alarm System conduits with red paint in accordance with Section 26 05 34 - Conduit and Fittings.
- F. Junction Boxes: Mark the circuit numbers of wiring on all junction boxes with sheet steel covers. Mark with indelible black marker. On exposed junction boxes in finished areas mark on inside of cover. Paint Fire Alarm System junction boxes with sheet steel covers red. Mark all other Special System junction boxes with sheet steel covers with appropriate system designation, e.g., "Intercom", "Clock", "Telecom", etc. Mark with indelible black marker. On exposed junction boxes in finished areas mark on inside of cover.
- G. Code Required Markings and Warnings: Provide all placards, markings and identification systems required by Code and/or the Contract Documents, such as (but not limited to):
  - 1. Arc Flash.
  - 2. "Series Rated Systems".
  - 3. Conductor insulation color identification.
  - 4. Special conductor identification and legends.
  - 5. Emergency systems markings.
  - 6. Multiple services placards.
  - 7. Emergency source grounded circuit conductor connected to a Grounding electrode at a location remote from the emergency source: Provide a sign at the Grounding location identifying all emergency and normal sources connected at that location.
  - 8. Warning messages shall include an appropriate plain language imperative command, such as "DANGER HIGH VOLTAGE - KEEP OUT".

#### 1.10 CLEARANCE STRIPING

- A. For electrical equipment located in areas with uncarpeted floors, the clearances dictated by NEC Article 110 shall be indicated by two inches wide colored striping on the floor.
- B. Striping shall be of a bright color (typically red or yellow) that contrasts with the floor color, and shall be applied by the most durable process that is commercially available for the particular floor finish. Examples are: epoxy paint on concrete floors, and colored tile segments in composition tile floors. Striping color and method shall be subject to approval by the Contracting Agency.
- C. On the floor immediately inside the striping, stencil in two inch block letters the statement: "ELECTRICAL CLEARANCE -- STORAGE ILLEGAL INSIDE THIS ZONE." For floor types where painted stenciling is not feasible or sufficiently durable, this message shall instead be posted on the wall below the equipment as an engraved label of the type specified in this Section, with 1/2-inch lettering. Note the specific clearance requirements on the engraved label.

### 1.11 AS-BUILT DRAWINGS

- A. Reference requirements stated elsewhere in these Specifications.
- B. In addition to other requirements, mark up a clean set of drawings as the work progresses, to show the dimensioned location and routing of all electrical work which will become permanently concealed. Show routing and location of items cast in concrete or buried underground. Show routing of work in permanently concealed blind spaces within the building. Show complete routing and sizing of any significant revisions to the systems shown.
- C. Maintain As-Built Drawings in an up-to-date fashion in conjunction with the actual progress of installation. Accurate progress mark-ups shall be available on-site for examination by the Contracting Agency or his representative at all times.
- D. Prepare wiring diagrams using the latest release of AutoCAD for all individual special systems as installed. Identify all components and show all wire and terminal numbers and connections. Include all diagrams from the shop drawings and Submittals, updated to show as-built condition.
- E. Contractor's red lines ("As-Builts"), shall be prepared in accordance with to the standard of care criteria as defined in this sub-section. The Contracting Agency reserves the right to reject any or all such As-Built Drawings if, in our opinion, these criteria have not been met or if the work is not clear. Any costs incurred as a result of the Contractor's failure to meet these criteria such as, but not limited to, resubmittals, meetings, site visits and written correspondence, shall be reimbursed as additional services. The acceptable standard of care includes the following:
  - 1. Full size As-Built Drawings shall be neatly marked-up by the Contractor to show actual installation conditions using the symbols, line types and abbreviations as shown in the contract document's legends and abbreviations. Red shall be used to show items to be added, green for items to be removed and blue for general clarification comments not to be drafted.
  - 2. All line work shall be drawn using a straight edge and all notes shall be neatly printed and legible. Leaders and sheet notes shall be used where necessary using a similar style to that shown throughout the Drawings.
  - 3. All under slab and otherwise inaccessible piping, ducting, and other components shall be accurately dimensioned to the nearest one-inch increment. Complete and submit As-Built Drawings that include inaccessible components, such as plumbing and heating piping and electrical conduit on underfloor plans involving slab on grade floor construction, for review prior to pouring of the slab.
  - 4. Where equipment is furnished having different dimensions than those shown, the Drawings shall be modified to show the dimensions of the equipment provided.
  - 5. Where equipment is shown in more than one drawing location, (i.e., plan and section), revised equipment arrangement shall be shown in all drawing locations.
- F. At completion of project, deliver the As-Built Drawings to the Contracting Agency and obtain written receipt.

### 1.12 OPERATING INSTRUCTIONS

- A. Prior to final acceptance, instruct an authorized representative of the Department for eight hours on the proper operation and maintenance of electrical systems and equipment provided under this contract. This requirement is for several systems, and is in addition to all special training specified in other sections. Make available a qualified technician for each component of the installation for this instruction. Give these operating instructions after the operation and maintenance manuals have been furnished to the Department. Submit written certification, signed by the Contractor and an authorized representative of the Department, that this has been completed.

### 1.13 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance Manuals in the manner described elsewhere in these specifications. In addition, organize manual and include data and narrative as noted below.
  - 1. Final Manuals shall be provided not later than one week prior to requesting inspection for Substantial Completion.
  - 2. Submit all 8-1/2 by 11 inch literature and equipment data in hard-back, three-ring, loose-leaf binders by individual sets. Cardboard or paper binders are unacceptable.
  - 3. Submit copies of all Operation and Maintenance Manuals in electronic format (Adobe PDF).
- B. Provide a separate chapter for each section of the electrical specifications with sub-chapters for each class of equipment or system. Provide a table of contents for each chapter, and each major item in each chapter, to indicate the page number of each. Provide a summary of product warranty terms and duration for each piece of equipment. Label all pages to assure correct placement in manual. Identify each piece of equipment with its associated specification description.
- C. Operating Sequence Narrative:
  - 1. In each chapter, describe the procedures necessary for personnel to operate the system and equipment covered in that chapter.
  - 2. Describe procedures for start-up, operation, emergency operation, and shutdown of each system. If a particular sequence is required, give step-by-step instructions in that order.
  - 3. Describe all seasonal adjustments that should be accomplished for each system.
  - 4. Provide the above descriptions in typewritten, simple outline, narrative form.
- D. Maintenance Instructions:
  - 1. Provide complete information for preventive maintenance for each product, including recommended frequency of performance for each preventive maintenance task.
  - 2. Provide instructions for minor repair or adjustments required for preventive maintenance routines, limited to repairs and adjustments that may be performed without special tools or test equipment and which require no extensive special training or skills.
  - 3. Provide all information of a maintenance nature covering warranty items, etc., that are not discussed in the manufacturers literature or the operating sequence narrative.
  - 4. Provide complete information data for all the spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
- E. Manufacturers' Brochures: Include manufacturers' descriptive literature covering all products used in each system, together with illustrations, exploded views and renewal parts lists. Highlight all applicable items and instructions, or mark-out non-applicable items.
- F. Shop Drawings: Provide a copy of all corrected, approved shop drawings for the project, updated to show as-built condition, either with the manufacturers' brochures or properly identified in a separate subsection.
- G. Operation and Maintenance Manuals shall be fully corrected to include review comments prior to final submission to the Department.

### 1.14 PROJECT COMPLETION AND DEMONSTRATION

- A. Tests: During final inspection, conduct operating tests for approval. Demonstrate installation to operate satisfactorily in accordance with requirements of Contract Documents. Should any portion of installation fail to meet requirements of Contract Documents, repair or replace items failing to meet requirements until items can be demonstrated to comply. Have instruments available for measuring light intensities, voltage, and current values and for the demonstration of continuity, grounds, or open circuit conditions. Furnish personnel to assist in taking measurements and making tests. In the event that systems are not complete and fully operational at the time of final inspection, all costs of any subsequent inspections shall be borne by the Contractor at no additional cost to the Department.

- B. Certificate of Completion: Submit at time of request for final inspection, a complete letter in the following format:
- I, \_\_\_\_\_ (Name), of \_\_\_\_\_ (Firm), certify that the electrical work is complete in accordance with Contract Plans and Specifications, and authorized change orders (copies of which are attached hereto) and will be ready for final inspection as of \_\_\_\_\_ (Date). I further certify that the following Specifications requirements have been fulfilled:
1. Megger readings performed, \_\_\_\_ copies of logs attached.
  2. Operating manuals completed and instruction of operating personnel performed, \_\_\_\_\_ (Date) \_\_\_\_\_ (Signed)  
Department's Representative
  3. Record document drawings up-to-date, accurate, and ready to deliver to Contracting Agency.
  4. Emergency systems tested and fully operational.
  5. Network Lighting Control System tested and fully operational.
  6. Fire Alarm System tested and fully operational.
  7. DVRS tested and fully operational.
  8. Hearing Impaired Audio System tested and fully operational.
  9. Sound System tested and fully operational.
  10. Security Management System tested and fully operational.
  11. Telecommunications System test reports have been submitted to and approved by the Contracting Agency. The test reports shall certify that the Telecommunications System is complete, passes all test criteria, is fully operational, and that all work has been witnessed as specified.
  12. Generation System and controls tested and fully operational.
  13. UPS System and controls tested and fully operational.
  14. Paging System tested and fully operational.
  15. Ground-fault system performance test complete, copies of logs attached.
  16. All other tests required by Specifications have been performed.
  17. All specified DEPARTMENT training complete.
  18. All systems are fully operational. Project is ready for final inspection.

SIGNED: \_\_\_\_\_ DATE: \_\_\_\_\_  
TITLE: \_\_\_\_\_

### 1.15 WARRANTY

- A. Warranty work shall be promptly coordinated and performed at the Contractor's sole expense. All workmanship, labor and materials (without limitation) in this Division shall be warranted for the longer of the following:
1. As called for in the General Conditions of the Contract.
  2. For a minimum period of one year from the date of final acceptance.
  3. For the extended warranty period specified in a specific Section under this Division.
- B. Where a specific product carries a longer warranty as a standard offering of its manufacturer, extended warranty coverage beyond these requirements shall be retained by the Department. The Department will have recourse back to the manufacturer only in these cases, when the warranty as specified in A above has expired.

## PART 2 - PRODUCTS - NOT USED

## PART 3 - EXECUTION

### 3.1 COORDINATION WITH ROOM NUMBERING

- A. Certain systems provided under this Division rely on identification systems that are based on room names or numbers. Systems labeled in this fashion include, but are not limited to, Panelboards, circuit directories, communication and data systems identifiers, fire alarm systems, etc.

- B. The numbering scheme indicated in these Contract Documents is based on room numbers assigned during the design process. The Department reserves the right to change the numbers prior to substantial completion, and the final names and numbers will not necessarily match those found in the Documents. Obtain from the Department the final room numbers prior to commencing the numbering of Divisions 26, 27 and 28 systems. Tag and label all system circuits and devices in accordance with the final numbering scheme at no additional cost.

### **3.2 ACCESS DOORS**

- A. Provide access doors required for access to equipment provided under Divisions 26, 27 and 28. Doors shall be rated for the surrounding construction. Use of access doors shall be minimized, and all locations and cosmetic features shall be submitted for approval in advance.
- B. Doors shall be finished to match surrounding surfaces as approved by the Contracting Agency.

**END OF SECTION 26 00 00**

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**SECTION 26 05 00**  
**BASIC MATERIALS AND METHODS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes specific requirements, products, and methods of execution, which are typical throughout the electrical work of this project. Additional requirements for the specific systems may modify these requirements.

**1.2 COORDINATION**

- A. Lay out the work in advance and avoid conflict with other work in progress. Physical dimensions shall be determined from existing conditions. Verify locations for junction boxes; disconnect switches, stub-ups, etc., for connection to equipment furnished by others, or in other Divisions of this Work.
- B. Refer to the "Suggested Coordination Schedule" in Section 20 00 00 - Mechanical General Requirements.

**1.3 SERVICEABILITY OF PRODUCTS**

- A. Furnish all products to provide the proper orientation of serviceable components to access space provided.
- B. Coordinate installation of panels, equipment, system components, and other products to allow proper service areas for items requiring periodic maintenance inspection or replacement.
- C. Replace or relocate products incorrectly ordered or installed.

**1.4 ACCESSIBILITY OF PRODUCTS**

- A. Arrange work to provide access to serviceable and/or operable products. Layout work to optimize net usable access space within confines of space available. Advise Contracting Agency, in a timely manner, of areas where proper access cannot be maintained. Furnish layout drawings to verify this claim, if requested.
- B. Provide access doors in ceilings, walls, floors, etc., for access to junction boxes, automatic devices, and serviceable or operable equipment in concealed spaces.

**PART 2 - PRODUCTS**

**2.1 MATERIALS AND EQUIPMENT FURNISHED IN DIVISIONS 26, 27 AND 28**

- A. Materials furnished and installed in permanent construction shall be new, full-weight, standard in every way, and in first class condition.
- B. Materials shall conform to the standards of an organization acceptable to the Authority Having Jurisdiction and concerned with product evaluation that maintains periodic inspection of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. Only materials designed for the purpose employed shall be used.
- C. Materials shall be identical with apparatus or equipment that has been in successful operation for at least two years. Materials of similar class or service shall be of one manufacturer.
- D. Capacities, sizes, and dimensions given are minimums unless otherwise indicated. Systems, materials and equipment proposed for use on this project shall be subject to review for adequacy and compliance with Contract Documents.

## 2.2 MATERIALS AND EQUIPMENT FURNISHED IN OTHER DIVISIONS

- A. Controls, including conduit, wiring, and control devices required for the operation of systems furnished in other Divisions shall be provided complete under the Division of the Specifications in which the equipment is specified, unless otherwise noted or specified.
- B. Work on the project that falls under the jurisdiction of the electrical trade shall be performed by Licensed Electricians in conformance with the electrical specifications.
- C. Provide complete power connections to equipment including but not limited to feeders, connections, Disconnects and motor running overcurrent protection. Where starters are provided as part of packaged equipment, overcurrent heaters shall be provided under Divisions 26, 27 and 28.

## PART 3 - EXECUTION

### 3.1 STORAGE AND HANDLING

- A. All items shall be delivered and stored in original containers, which shall indicate manufacturer's name, the brand, and the identifying number. Items subject to moisture and/or thermal damage shall be stored in a dry, heated place. Items shall be covered and protected against dirt, water, chemical, ultraviolet (UV) and/or mechanical damage.

### 3.2 PROTECTION OF MATERIAL AND EQUIPMENT

- A. The Contractor shall be responsible for any and all materials and equipment to be installed under this Contract. The Contractor shall make good at his own cost any injury or damage which said materials or equipment may sustain from any source or cause whatsoever before final acceptance.

### 3.3 INSTALLATION

- A. Skilled craftsmen shall install all materials and equipment. The norms for execution of the work shall be in conformity with NEC Chapter 3 and the National Electrical Contractors Association "National Electrical Installation Standards", which herewith is made part of these specifications.
- B. Repair surfaces and furnish all required material and labor to maintain fireproof, airtight and waterproof characteristics of the construction.
- C. Installation of equipment shall be in accordance with manufacturers' instructions.

### 3.4 MULTIWIRE BRANCH CIRCUITS

- A. Multiwire branch circuits shall not be used on this project. Each branch circuit shall be provided with its own dedicated neutral conductor.

### 3.5 MOUNTING HEIGHTS

- A. Mounting height shall be to center of box above finished floor (AFF) as noted below unless otherwise shown or indicated. Other mounting heights are indicated on the Drawings by detail. Specific dimensions AFF are shown adjacent to the symbol. Where devices are shown on architectural elevations, the elevation height shall govern.

Lighting switches	48 inches
Lighting Scene Controller	48 inches
A/V Switching Control	48 inches
Convenience outlets and similar devices	16 inches (see note below)
Convenience outlets in mechanical, boiler rooms, shops and workrooms	48 inches

Motor controllers	60 inches to top
Panelboards	72 inches to top
Exterior WP convenience outlets	24 inches AFG
Speakers	90 inches
Telecommunications (Data/Telephone) outlets	16 inches (see note below)
Welder outlets	48 inches
Wall mounted audible and/or visual appliances such as bells, horns, strobes and similar signal devices	90 inches (or 6 inches below ceiling height for ceiling heights less than 96 inches)
Manual fire alarm box	48 inches (or 48 inches to operable part where operable part of device is above centerline of device)
Fire Alarm Control Panel (FACP)	72 inches to top
Fire Alarm Text Annunciator (FAA)	60 inches to center
Security Keypad	60 inches to center
Security Card Reader	40 inches to center

- B. NOTE: In locations where baseboard-heating enclosures are to be installed, outlet-mounting height shall be raised to 6 inches above top of enclosure unless otherwise noted on drawings.

### 3.6 CUTTING & PATCHING

- A. Obtain written permission of the Contracting Agency before cutting or piercing structural members.
- B. Sleeves through floors and walls shall be galvanized steel pipe, flush with walls, ceilings or finished floors, sized to accommodate the raceway. Grout all sleeve penetrations through concrete walls or floors. Holes through existing concrete shall be core drilled. X-ray concrete before core drilling. Do not cut rebar without specific authorization from the Contracting Agency. Seal openings with UL Listed fire resistant resilient sealant.

### 3.7 VAPOR RETARDER/BARRIER PENETRATIONS

- A. Penetrations of the building vapor retarder/barrier caused by the electrical installation shall be minimized, and where they are necessary, the opening in the vapor retarder/barrier shall be cut smaller than the penetrating object, so that the penetration will be a stretch fit. The penetration shall then be securely sealed with vapor-barrier tape or an adhesive or caulk compatible with the surfaces being sealed.
- B. Boxes (electrical boxes, Outlet Boxes and telecommunication boxes, etc) penetrating walls with vapor retarder/barriers shall be sealed airtight using STI Series SSP Firestop Putty Pads. Mold putty pads around electrical junction boxes and conduits and behind vapor retarder/barrier to form an airtight seal in accordance with manufacturer's installation instructions.

### 3.8 FIRE RESISTIVE CONSTRUCTION

- A. Provide "tenting" or other protection acceptable to the Authority Having Jurisdiction for devices or fixtures installed in fire resistive construction (i.e., ceilings, walls, etc.) to maintain the fire resistive rating of the complete assembly.

- B. Where electrical raceways or other features penetrate fire rated building surfaces, they shall maintain the integrity of the building surface being penetrated. This shall be accomplished with either of the following methods:
  - 1. Sealing the penetration with an approved fire rated caulk or putty.
    - a. Fire rated caulk or putty: 3M Fire Barrier Caulk No. CP25, 3M Fire Barrier Moldable Putty, or as approved.
  - 2. A fire rated assembly enclosing the penetration.
    - a. Fire rated assembly: STI EZ Path, or as approved.
  - 3. All firestopping shall be applied according to the manufacturer's recommendations, and in a manner that is listed by a nationally-recognized independent testing agency (such as UL) as preserving the fire time-rating of the construction.

### 3.9 SOUND ISOLATION

- A. Where electrical raceways or other features penetrate walls that extend to structure, they shall maintain the integrity of the building surface being penetrated. Refer to the requirements of FIRESTOPPING as specified above. Note that this requirement exists regardless of whether the building surface being penetrated has a fire rating.
- B. Boxes (electrical boxes, Outlet Boxes and telecommunication boxes, etc) penetrating wall types that extend to structure or that contain batts shall be sealed airtight using STI Series SSP Firestop Putty Pads to reduce sound transmission. Mold putty pads around electrical junction boxes and conduits to form an airtight seal in accordance with manufacturer's installation instructions.

### 3.10 PROTECTIVE FINISHES

- A. Take care not to scratch or deface factory finish of electrical apparatus and devices. Repaint marred or scratched surfaces.
- B. Provide hot dip galvanized components for ferrous materials exposed to the weather.

### 3.11 SEPARATION OF SYSTEMS

- A. Conductors and equipment of different voltage levels, frequency, current characteristics (AC & DC) or functions (normal vs. emergency, etc.) shall not share the same raceways or enclosures unless specifically shown on the Drawings or approved by the Contracting Agency, or inherently necessary for correct system function (i.e., at transfer switches, transformers, etc.)

### 3.12 TESTING

- A. Prior to final test, all switches, Panelboards, devices, and fixtures shall be in place.
- B. Test all electrical systems. They shall be free from short circuits and unintentional grounds.
- C. Make changes necessary to balance the actual electrical loads on the complete system. Arrange for balanced conditions of circuits under connected load demands, as contemplated by the normal working conditions. Final load and balance test shall be demonstrated in the presence of the Contracting Agency.
- D. Feeder cables shall be megger tested prior to final termination. If conductor fails test, replace wiring or correct defect and retest. Perform a 1,000 volt megohm meter test on each circuit cable rated 600 volts between the conductor and ground. Submit logs of all megger readings. The insulation resistance between conductor and ground shall not be less than the following:
  - 1. 8 megohms for a single conductor length of less than 2,500 feet
  - 2. 6 megohms for a total single conductor length of 2,500 feet and over
- E. Conduct a performance test of the ground-fault protection system in accordance with NEC Article 230.95(C) and the equipment manufacturer's instructions. Prior to the actual ground-fault protection system test, the service shall be de-energized, the neutral bus-link opened,

and the entire 480V system neutral megger-tested to ensure that it is free of grounds downstream of the ground-fault sensing. Grounds detected shall be located and removed, so that the neutral tests clear of grounds, before proceeding with the ground-fault testing.

- F. Furnish one (1) copy of certified test results to the Contracting Agency prior to final inspection.

**3.13 CLEAN-UP**

- A. Throughout the work, the Contractor shall keep the work area reasonably neat and orderly by frequent periodic cleanups.
- B. As independent parts of the installation are completed, they may be tested and utilized during construction.

**END OF SECTION 26 05 00**

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**SECTION 26 05 10  
WIRE AND CABLE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes specific requirements, products, and methods of execution relating to Wire and Cable, 600 volts or less, approved for use on this project.

**1.2 QUALITY CONTROL**

- A. Conductors shall be sized according to American Wire Gauge (AWG). Stranding, insulation, rating and geometrical dimensions shall conform to UL and ICEA specifications.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**PART 2 - PRODUCTS**

**2.1 INSULATION TYPES**

- A. Branch circuit conductors shall be 600 volt insulated, and unless otherwise noted on the Drawings, shall have the following insulation types:
1. Heated indoor spaces - THHN/THWN or XHHW.
  2. Outdoors, wet locations (such as slab-on-grade), or other cold locations (such as unheated attics) - XHHW.
- B. Feeder conductors shall be 600 volt insulated, and unless otherwise noted on the Drawings, shall have the following insulation types:
1. Heated indoor spaces - THHN/THWN or XHHW-2.
  2. Outdoors, wet locations (such as slab-on-grade), or other cold locations (such as unheated attics) - XHHW-2.
- C. Nylon-jacketed conductors such as Types THHN or THWN shall not be used in any location subject to ambient temperatures below 20° F.
- D. Special applications: Conductors in fluorescent fixture wiring channels shall have 90° C insulation rating, Types THHN, XHHW, or equal. Conductors in high temperature locations shall have one of the special insulation types suitable for the use and as permitted by the NEC.

**2.2 FLEXIBLE CORD**

- A. Flexible cord shall be Type SO or ST, or for the larger sizes, Type G.

**2.3 MISCELLANEOUS**

- A. Miscellaneous: Miscellaneous Wire and Cable for special purpose applications and not covered in the categories as indicated above or otherwise specified, shall be as shown on the plans and/or required by the intended use.

**2.4 MINIMUM SIZE**

- A. Unless specified otherwise minimum wire sizes shall be as follows:
1. #12 AWG for branch circuit wiring.
  2. #20 AWG for low voltage switching circuits if part of an approved cable assembly, #18 AWG otherwise.
  3. #14 AWG for control circuit wiring.

4. #16 AWG for light fixture whips, refer to specification section 26 05 34 - Conduit and Fittings, for maximum fixture whip lengths.
- B. On 20A circuits, with one-way conductor lengths measured from panel to farthest receptacle, or center of lighting string (as applicable):
  1. #10 AWG for 120V circuits of 75' to 120'.
  2. #8 AWG for 120V circuits of 120' to 200'.
  3. #10 AWG for 277V circuits of 130' to 215'.
  4. #8 AWG for 277V circuits of 215' to 330'.
- C. Similar over sizing shall apply to circuits of other ratings and/or greater lengths, as necessary to comply with the voltage drop limitations in Part 3 of this Section.
- D. Cable or conductors for fire alarm systems and other special systems shall be as described in other sections of the specifications, noted on the drawing, or recommended by the equipment manufacturer, whichever is greater.

## 2.5 CONDUCTORS

- A. Conductors used on this project shall be copper, solid or stranded for wiring #10 and smaller, stranded for #8 and larger.
- B. Stranded control, communication, and alarm conductors shall have compression terminations where terminated on screw terminals.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Unless otherwise noted or specified, conductors shall be run in raceways as specified in Section 26 05 34 - Conduit and Fittings. Raceways shall be installed as a complete system, free from obstructions, and clean before conductors are installed.
- B. Provide conductors from outlet to outlet and splice branch circuit conductors only at outlet or junction boxes. Install conductors in a single raceway at one time and leave sufficient cable at fittings or boxes. Keep conductors within the manufacturer's allowable tension. Do not violate minimum bending radii. Lubricants for wire pullings, if used, shall conform to UL requirements for the insulation and raceway material.
- C. Do not install Type XHHW conductors in temperatures below -10° F, or the other types in temperatures below +20° F.
- D. Conductors that extend below grade shall be suitable for wet locations (type XHHW or XHHW-2). The use of THHN below grade is not acceptable.

### 3.2 CONDUCTOR SUPPORT

- A. Provide conductor supports as recommended by the NEC or cable manufacturer in vertical conduits.

### 3.3 SPLICING

- A. No splicing or joints are permitted in branch circuits except at outlet or accessible junction boxes. Prior to splicing, conductors shall be stripped to the exposed length recommended by the splicing device manufacturer.
- B. Utilize compression type solderless connectors when making splices or taps in conductors No. 8 AWG or larger. Provide heat or cold shrink type insulating tubing on all splices and tape outer surface continuously with Scotch #88 plastic tape to secure insulation strength equal to that of the conductors joined.

- C. Utilize pre-insulated connectors, hard-shell type only, Ideal Industries, Inc., "Wing-Nut" or "Twister Pro" for splices and taps in conductors No. 10 AWG and smaller in dry locations.
- D. Utilize Ideal "Twister DB Plus", water repellent, sealant filled, UL 486D Listed connector splices and taps in conductors No. 10 AWG and smaller in damp or wet locations.
- E. Utilize "Buchanan pre-insulated crimp connectors" on stranded conductors for fire alarm control and alarm circuits.
- F. Feeder conductors shall be installed with no splices.

### 3.4 CONDUCTOR TERMINATION

- A. Provide power and control conductors that terminate on equipment or terminal strips with solderless lugs or T & B "Sta-Kon" terminals.
- B. Prior to termination, conductors shall be stripped to the exposed length recommended by the termination device manufacturer.

### 3.5 CONDUCTOR PHASE COLOR CODING

- A. Service, feeder and branch circuit conductors throughout the project secondary electrical system shall be color coded as follows:

208/120 Volts	Phase	480/277 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray (see following)
Green	Ground	Green

Permanently post conductor color code at each panelboard in accordance with NEC Article 210.

- B. Where color coded conductors are not commercially available, colored non-aging, plastic tape may be utilized where permitted by NEC.
- C. Where neutrals of different systems exist on the project, neutral conductor identification method shall satisfy the Authority Having Jurisdiction, as to compliance with NEC Article 200.
- D. Phases in Panelboards and similar equipment shall be connected Phase A, B, C from left to right, top to bottom, or front to back.

### 3.6 DERATING OF CONDUCTORS

- A. Derating of conductors shall be per National Electrical Code.

### 3.7 VOLTAGE DROP

- A. The maximum total voltage drop shall not exceed three (3) percent in branch circuits or feeders, for a total of five (5) percent to the farthest outlet based on steady state design load conditions. Wire sizes shown on the Drawings are for minimum ampacity. Wire and conduit sizes shall be increased to limit voltage drop based upon actual lengths required in the field. Base voltage-drop calculations on NEC Chapter 9, Table 9.

**3.8 OPEN WIRING ABOVE LAY-IN CEILINGS PROHIBITED**

- A. Wiring for all systems shall be installed in one of the raceway systems or Cable Tray systems listed for this project. Refer to the Drawings and the specific Section under which each system is specified.
- B. Wiring installed in Cable Trays in air-handling ceiling spaces shall be approved for the application and the specific system.
- C. Raceways and sleeves shall be sized in accordance with the cabling requirements for the special system involved.

**3.9 TESTING**

- A. Feeder cables shall be megger tested prior to final termination in accordance with Section 26 05 00 - Basic Materials and Methods.

**END OF SECTION 26 05 10**

**SECTION 26 05 29  
HANGERS AND SUPPORTS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes:
  - 1. General hanger and support requirements for electrical equipment, conduit and Cable Trays not required to be vibration and/or seismically controlled.
  - 2. Penetrations, sleeves and seals.
- B. Products Installed But Not Supplied Under this Section:
  - 1. Vibration Isolation and Seismic Control anchoring and support systems furnished under Section 13 48 00 - Vibration and Seismic Control.
- C. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. Division 3 - Cast-In-Place-Concrete
  - 3. Division 9 - Painting
  - 4. 13 48 00 - Vibration and Seismic Control
  - 5. 26 00 00 - Electrical General Requirements
  - 6. 26 05 00 - Basic Materials and Methods
  - 7. 26 05 34 - Conduit and Fittings
  - 8. 26 05 36 - Cable Tray
  - 9. 26 22 00 - Secondary Transformers
  - 10. 26 24 16 - Panel Boards
  - 11. 26 26 30 - Motor Starters
  - 12. 26 29 13 - Distribution Switchboards
  - 13. 26 30 00 - Emergency Standby Generation System
  - 14. 26 50 00 - Lighting Fixtures
  - 15. 27 20 10 - Telecommunications Distribution System

**1.2 REFERENCES**

- A. International Electrical Code (IEC) 2008
- B. National Electrical Code (NFPA-70)

**1.3 DESCRIPTION**

- A. Provide general hanger and support requirements for electrical equipment, conduit and Cable Trays not required to be vibration and/or seismically controlled in accordance with the manufacture's written installation instructions and NFPA-70.
- B. Coordinate directly with Section 13 48 00 - Vibration and Seismic Control to identify electrical equipment and systems which require vibration and/or seismic control bracing in addition to the requirements of this section.

**1.4 SUBMITTALS**

- A. See Section 26 00 00 - General Electrical Requirements for general submittal requirements
- B. Product Data:
  - 1. Provide manufacturers catalog data for each product specified. Indicate channel gauge and maximum load capacities of the selected products.
  - 2. Manufacturer's Installation Instructions: Include assembly instructions, recommended parts and special procedures as required.
- C. Shop Drawings:

1. Provide a single shop drawing submittal which integrates the shop drawing requirements of this section along with the additional requirements of Section 13 48 00 - Vibration and Seismic Control.
2. Provide shop drawings to include the following:
  - a. Housekeeping pads (coordinated with approved electrical equipment footprints and anchor point locations).
  - b. Pre-engineered and field fabricated support system details for each installation location. To include but not limited to:
    - 1). Raceway and lighting fixture support.
    - 2). Conduit and control panel support.
    - 3). Switch box support.
    - 4). Cable tray support (single and multi-tier)
    - 5). Trapeze hangers
    - 6). Electrical equipment support.
  - c. Equipment locations and conduit and Cable Tray routing coordinated with mechanical equipment and systems. Indicate routing height above finished floor.
  - d. Indicate hanger type/attachment method and hanger spacing intervals.
- D. Project Record Information:
  1. Indicate installed locations of Hangers and Supports on project as-built drawings.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site:
  1. Verify products are delivered in original factory packaging and are free from damage and corrosion.
  2. Replace equipment delivered to job site that does not comply with above requirements at no expense to the Department.
- B. Storage and Protection:
  1. Store products in covered storage area, protected from the elements, outside the general construction area until installed.

### 1.6 WARRANTY

- A. Provide warranty in accordance with Section 26 00 00 - General Electrical Requirements.

## PART 2 - PRODUCTS

### 2.1 PRE-ENGINEERED SUPPORT SYSTEMS

- A. Manufacturers:
  1. Unistrut
  2. Super-Strut
  3. B-Line
  4. K-Line
  5. Erico.
- B. Material:
  1. Cold worked steel.
  2. Type 304 stainless steel: Use for PVC, liquid-tight flex, or plastic-coated conduit installed on wood construction in outdoor, damp, corrosive or marine environments.
- C. Finish:
  1. Heated indoor areas: Pre-galvanized zinc coating.
  2. Outdoor areas: Hot dipped galvanized finish. In addition, coat hot dipped galvanized finish channel field cuts with zinc rich paint provided by the support system manufacturer.
  3. Painted areas: Paintable galvanizing or phosphatized and primed.
  4. Surface metal raceways: U.L. Listed epoxy coating.

- D. Channel:
  - 1. Standard Size: 1-5/8 inch x 1-5/8 inch. Gauge thickness as required for attached load.
  - 2. Standard Hole Pattern: Slotted. Provide solid channel in exposed public areas.
- E. Nuts and Hardware:
  - 1. Channel nuts: Hardened steel (ASTM-A675 and ASTM A36).
  - 2. Bolts, screws and nuts: Hardened steel (ASTM-A307, ASTM A563 and SAE J429).
  - 3. Finish: Electroplated zinc
- F. Fittings: Plate steel (ASTM A635). Epoxy or electroplated zinc coating
- G. Electrical Accessories: Provide accessories from the support system manufacturer designed for the specific equipment to be supported to include but not limited to:
  - 1. Fluorescent fixture hangers.
  - 2. Outlet box adapters.
  - 3. Snap-in closures.
  - 4. Conduit connection plates.
  - 5. Junction box adapters.
  - 6. Strut joiners.
  - 7. "Caddy" fasteners are permitted for support of conduit to concealed metal studs and for conduit concealed above suspended acoustical ceilings.

## **2.2 SLEEVES, ACOUSTICAL SEALS AND FIRE-STOPPING**

- A. See Part 3 - PENETRATIONS.

## **2.3 WALL/FLOOR PENETRATION WATER SEALS**

- A. Mechanical seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and the wall opening.
- B. EPDM seals.
- C. 316 Stainless steel bolts and nuts.
- D. Hot-dipped galvanized or coated sleeve with full water stop flange with continuous weld on both sides.
- E. Manufacturer: Metraflex, Thunderline, Crouse-Hinds, or pre-approved equal.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Prior to installation, prepare detailed shop drawings of the planned installation of hanger and support products specified by this section. Coordinate the location, type and size of Hangers and Supports, housekeeping pads (thickness/perimeter overhang dimensions) and roof curbs with Architectural and Structural elements utilizing the shop drawing review process.
- B. Submit shop drawings required by this section coordinated with the seismic design and associated shop drawings required by Section 13 48 00 - Vibration and Seismic Control as a single submittal.
- C. Do not install Hangers and Supports without approved shop drawings.

### **3.2 GENERAL INSTALLATION**

- A. Install Hangers and Supports in accordance with manufacturer's instructions, applicable Code requirements (NFPA-70) and approved shop drawings.
- B. See Section 26 05 00 - Basic Materials and Methods for electrical equipment wall mounting heights.

### 3.3 VIBRATION AND SEISMIC CONTROL PRODUCT INSTALLATION

- A. Install vibration isolators, seismic control and wind restraint systems in strict compliance with the manufacturer's written instructions and certified and approved application engineering installation drawings and details in accordance with Section 13 48 00 - Vibration and Seismic Control.

### 3.4 INSERT AND ATTACHMENT INSTALLATION

- A. Caution: Project contains cast in place radiant floor heating tubing. Coordinate slab penetration locations so as not to damage tubing.
- B. Inserts
  1. Provide inserts or cast-in-place channels for placement in concrete formwork.
  2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  4. Use expansion type anchor bolts with pre-cast concrete including concrete masonry units within loading limits of the pre-cast material and anchor bolt manufacturer's recommendations.
  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.
  6. Plastic screw inserts and caulked lead inserts are prohibited, except for mounting instructions and control diagrams.
- C. Attach electrical equipment to structure as follows:
  1. Hollow masonry: Toggle bolts.
  2. Solid masonry and concrete: Preset inserts or expansion bolts.
  3. Structural steel: Beam clamps which engage both sides of structural member or have retaining clips or other approved means for positive engagement.
  4. Metal surfaces: Machine screws, bolts or welding.
  5. Wood construction: Wood or sheet metal screws.
  6. Do not use powder-actuated fasteners for anchorage in tension applications. Obtain written permission from the Department prior to using any type of powder powered studs.

### 3.5 RACEWAY INSTALLATION

- A. Support raceways using approved types of wall brackets, ceiling trapeze hangers or malleable iron straps. "Perforated plumber's strap" is not permitted as a means of support.
- B. Support raceways independent of ceiling systems, piping and ductwork. Exceptions: Lighting Fixtures and Outlet Boxes (i.e. ceiling speaker boxes) specifically designed for attachment to suspended ceiling systems
- C. Support EMT conduit (1-1/2 inch and smaller/dry locations) using hanger rods with spring steel fasteners.
- D. Support Cable Trays and multi-conduit runs independently from other support systems utilizing double hanger rods at each support point.

### 3.6 LIGHTING INSTALLATION

- A. General
  1. Attach safety hanger wires to Lighting Fixtures such that in event of a ceiling suspension system failure, no part of the fixture will drop more than 6 inches below normal ceiling height. Secure each end of each wire with a minimum of three tight wraps.
- B. Fixtures (greater than 20 pounds/non-suspended ceiling applications)
  1. Support Lighting Fixtures from structural members capable of supporting the total weight of the fixture and independent from electrical wiring system. Attach to steel members using approved beam clamps and rods.

- C. Fixtures (suspended ceiling system applications)
  - 1. Positively attach Lighting Fixtures to suspended ceiling grid for 100 percent of fixture weight acting in any direction using positive clamping devices that fully surround the supporting member (i.e. Caddy "IDS" or equal).
  - 2. Provide supplemental safety hanger wires as follows:
    - a. Fixtures (weighting less than 56 pounds): Provide two 12 gauge wires or equivalent chains connected from the diagonal corners of the light fixture housing to the structure above. These wires may be slack.
    - b. Fixtures (weighting greater than 56 pounds): Provide full direct support from the structure above. Attach wires from within 3 inches of each corner of the fixture.
    - c. Pendant hung Lighting Fixtures
      - 1). For each fixture, provide direct support from the structure above using a minimum of two 12 gauge wires, equivalent aircraft cable or an approved alternate support system without using the ceiling suspension system for direct support. Securely attach wire/cable to fixture, route through fixture stem and securely attach to structure.
      - 2). Provide loop and hook or swivel hanger assemblies fitted with a restraining device to secure stem in the support position during earthquake motion.
      - 3). Support fluorescent fixtures with flexible hanger device at the attachment point to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

### 3.7 PENETRATIONS

- A. Coordinate electrical penetrations with architectural, structural and mechanical construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
- B. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
- C. Provide penetrations through roof, exterior walls and floors (See floor penetration seals) to be weather and water tight.
- D. Fire-Stopping; Provide UL rated fire-stopping assemblies for rated roof, wall and floor penetrations in accordance with Division 7.
- E. Conduit Sleeves
  - 1. Provide sleeves for conduit passing through floors, walls, ceilings, or roofs.
    - a. Fabricate sleeves in non-load bearing walls from 20 gauge galvanized sheet steel conforming to ASTM A 924/A 924M.
    - b. Fabricate sleeves in load bearing walls from standard weight galvanized steel pipe conforming to ASTM A 53/A 53M.
    - c. Provide 1/2 inch clearance between conduit and sleeve opening.
  - 2. Provide escutcheons for conduit passing through walls, floors and ceilings in finished areas, below counters and inside closets and casework subject to view when doors are open. Size escutcheons to cover sleeves. Secure escutcheons in position.
- F. Acoustical Seals
  - 1. Monolithic sound walls (i.e. poured concrete or masonry): Provide wall sleeve with approximately one-inch annular space around conduit. Pack annular space with backer rod or acoustical filler as specified in Division 7. Allow a 1 inch recess at each end of sleeve. Caulk sleeve flush with flexible sealant or fire-stopping material as specified in Division 7.
  - 2. Where acoustical wall is a two component type, such as a staggered or double stud partition, treat each component as a separate wall. Pack and seal each half of penetration sleeve as previously specified, except that only the exposed end of each

sleeve portion shall be caulked with sealant or fire-stop. Provide adequate separation between each sleeve.

G. Wall Penetration Seals

1. Provide pre-engineered wall penetration water seal systems for exterior wall penetrations.
2. Select appropriate wall penetration sealing systems based on conduit material and nominal conduit size in accordance with the manufacturer's selection charts.
3. Install conduit and sealing system prior to waterproofing the wall. Grout void between water seal and outside face of foundation wall to provide continuous bearing surface for waterproofing fabric.

H. Floor Penetration Seals

1. Provide pre-engineered floor penetration water seal systems for conduit floor penetrations in rooms where a pipe leak/failure could result in water damage to adjacent spaces (i.e. mechanical rooms located above the ground floor or basement) and other areas as noted.
2. Extend conduit floor penetration sleeves 2 inches above finished floor.

**3.8 ROOF FLASHING**

- A. Provide EDPM pipe penetration and roof curb flashing in accordance with Section 07 50 00 - Single-Ply EDPM Membrane Roofing as an integral part of the roofing system.

**3.9 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FT checklists in accordance with Section 01 91 00 - Commissioning.

**END OF SECTION 26 05 29**

**SECTION 26 05 33  
OUTLET BOXES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general requirements, products and methods of execution relating to Outlet Boxes for use with Wiring Devices, lighting fixture outlets and telecommunications outlets approved for use on this project. Unless otherwise specified or noted on the Drawings, Outlet Boxes shall be sized per the National Electrical Code.

**1.2 QUALITY CONTROL**

- A. Underwriters' Laboratory listing for intended usage is required. Manufacturer and Model numbers shall be as indicated herein.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**PART 2 - PRODUCTS**

**2.1 CAST BOXES**

- A. Cast boxes with threaded hubs, external mounting brackets or holes, and gasketed covers shall be used in the following locations:
  - 1. Exterior locations.
  - 2. Wet or damp locations.
  - 3. Shops and mechanical rooms, where exposed to mechanical damage.
  - 4. Floor boxes installed in concrete.
  - 5. Exposed interior locations below 48 inch above floor.
  - 6. Where shown on Drawings.

**2.2 STEEL BOXES**

- A. Galvanized pressed steel boxes may be used wherever they are permitted by code, except in areas indicated in the preceding paragraph.
- B. Flush mounted, pressed steel boxes shall be equipped with external mounting brackets for attachment to framing members with screws or nails.
- C. Ceiling boxes and wall boxes for bracket lights shall be not less than 4 inch in diameter by 1 ¼ inch deep and shall have 3/8 inch malleable iron fixture studs if required.
- D. Grounding Screw: Stamped steel boxes shall have a drilled and tapped hole in the back of the box for a Grounding screw.
- E. Accessories: Box covers, extension rings, bases, hanger bars, etc., for use in connection with the installation, shall be approved for use in the various applications.

**2.3 TELECOMMUNICATION OUTLET BOXES**

- A. Boxes for telecommunication outlets shall be a minimum of 4 inches square by 2 1/8 inches deep.
- B. Device rings for telecommunication outlets shall be single-gang, minimum 5/8 inches deep, to provided a minimum internal finished depth of 2 3/4 inches.

## 2.4 FLOOR BOXES – TYPE A

- A. Type "A" floor boxes (as indicated on the Drawings) shall have the following features:
  - 1. Cast iron construction
  - 2. Fully adjustable
  - 3. Aluminum collar
  - 4. Round opening, 3.05 inches in diameter
  - 5. Require a minimum pour depth of not greater than 4"
  - 6. Four ¾ inch threaded conduit access holes
  - 7. Hubbell part number BA2536 or as approved.
- B. Single service covers for Type "A" floor boxes shall be aluminum duplex flap type.
  - 1. Hubbell part number SA3925 or as approved.
- C. Aluminum carpet flanges shall be used in areas with carpeting.
  - 1. Hubbell part number SA3182 or as approved.
- D. Floor boxes shall be UL listed for scrub water exclusion per UL514A.

## 2.5 FLOOR BOXES – TYPE B

- A. Type "B" floor boxes (as indicated on the Drawings) shall have the following features:
  - 1. Steel construction
  - 2. Adjustable up to 1/2 inch after concrete pour
  - 3. Rectangular opening to fit recessed cover
  - 4. Require a minimum pour depth of not greater than 4-1/2 inches
  - 5. Shall have six chambers for cable entrance and have multiple knockouts sized to accept conduit from ¾ inch to 2 inch in each chamber.
  - 6. Wiremold part number EFB6S or as approved.
- B. Recessed covers for Type "B" floor boxes shall be nickel with two cable doors and latch turn handle.
  - 1. Wiremold part number EF610BTNK for areas with concrete, tile or terrazzo flooring and EF610CTNK with carpet insert for areas with carpeting, or as approved.
- C. Type "B" boxes shall be able to accept 2-3/4" x 4-1/2" standard size wall plates, quantities and types as indicated on the drawings.
- D. Floor boxes shall be UL listed for scrub water exclusion per UL514A.

## 2.6 FLOOR BOXES – TYPE C

- A. Type "C" floor boxes (as indicated on the Drawings) shall have the following features:
  - 1. Cast iron construction
  - 2. Adjustable up to 1/2 inch after concrete pour
  - 3. Rectangular 2-gang opening with divider to fit recessed cover
  - 4. Require a minimum pour depth of not greater than 3-1/2 inches
  - 5. Shall have two chambers for cable entrance and have three 1 inch conduit openings in each chamber.
  - 6. Wiremold part number 880S2-1 or as approved.
- B. Recessed covers for Type "C" floor boxes shall be brass.
  - 1. Wiremold part number EF610BTNK for areas with terrazzo flooring or as approved.
- C. Type "C" boxes shall have the following cover plates:
  - 1. One brass flip lid duplex receptacle plate Wiremold part number 828R
  - 2. One brass flip lid communications plate Wiremold part number 828COMTC
- D. Floor boxes shall be UL listed for scrub water exclusion per UL514A.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Outlet boxes shall be securely fastened in position and supported independently of the conduit system.
- B. Outlet boxes located in suspended ceiling system shall be fastened to ceiling "t-bar" system with bar-hanger rods manufactured for the purpose, or from hanger rods with solid supports from structure above. "T-bar" hanger rods shall be clipped to cross-members supported by the main ceiling support members. Outlet Boxes supported from the suspended ceiling system shall be provided with one safety wire attached to the box or box support clip, or two safety wires attached to the bar hanger.
- C. Boxes shall be installed true to the building lines and at equal heights in conformity with mounting heights specified in other sections of the specification.
- D. Provide the best suitable box for each outlet requirement. Extension rings shall not be used on new construction except where needed to bring an outlet box out to 1/8 inch of the finished wall or ceiling line.
- E. Boxes shall have only the holes necessary to accommodate the conduits at point of installation. Boxes shall have lugs or ears to secure covers.
- F. Boxes shall be rigidly secured in position. Recessed boxes shall be so set that the front edge of the box shall be flush with the finished wall or ceiling line, or not more than 1/8 inch back of same. This requirement is more stringent than NEC requirements.
- G. Boxes shall be accessible.
- H. Provide boxes for each application that will not violate the fire rating of the wall, floor or ceiling assembly in which the box is installed.
- I. Do not place order for floor boxes without ensuring that the Contracting Agency has positively approved Submittals for the specific cover types/styles colors necessary for all applications and locations.
- J. Recessed boxes shall not be placed back-to-back in adjacent rooms. They shall be offset at least 12 inches, or greater as required by codes and standards applicable to the specific construction.
- K. Boxes (electrical boxes, Outlet Boxes and telecommunication boxes, etc) penetrating fire rated walls, walls with vapor retarder/barriers, wall types that extend to structure or wall types that contain batts shall be sealed airtight with approved Firestop Putty Pads to form an airtight seal in accordance with manufacturer's installation instructions. Refer to Section 26 05 00 for additional information.

**END OF SECTION 26 05 33**

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**SECTION 26 05 34  
CONDUIT AND FITTINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes specific requirements, products, and methods of execution relating to conduit and conduit fittings approved for use on this project. Type, size and installation methods shall be as shown on Drawings, required by Code and specified in this Section.

**1.2 QUALITY CONTROL**

- A. Conduit and conduit fittings shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials and be in conformity with applicable standards and UL listings.

**1.3 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**PART 2 - PRODUCTS**

**2.1 CONDUIT**

- A. Conduit types specifically approved for use on this project shall be of the following types only:
1. Galvanized rigid metal conduit - GRC or RMC.
  2. Intermediate metal conduit - IMC.
  3. Rigid copper-free aluminum conduit.
  4. Electrical metallic tubing - EMT.
  5. Polyvinyl chloride conduit - PVC: May be Schedule 40 or Schedule 80, except where Schedule 80 is specifically noted or specified.
  6. Flexible metal (steel) conduit - FMC or flex: In short lengths as specifically permitted.
  7. Liquid-tight flexible steel conduit - LFMC: In short lengths as specifically permitted.
  8. Extreme temperature liquid-tight flexible steel conduit - AT: Shall have temperature rating of -67 ° F to +220 ° F, Liqueatite "ATLA", or as approved.
  9. Types specifically identified on the Drawings or in the Specifications
  10. Other products not specifically approved such as ENT, MC Cable, etc., are not allowed.

**2.2 FIRE ALARM CONDUIT**

- A. EMT conduit utilized for fire alarm system wiring shall be factory pre-painted with a bright red topcoat, Allied Fire Alarm Red or as approved. Other conduit types utilized for fire alarm system wiring shall be identified with red paint or red tape wrapped a minimum of 4 times around the conduit every 10 feet and at each fire alarm system junction box.

**2.3 FITTINGS**

- A. Fittings utilized with rigid steel, IMC, and aluminum shall be galvanized steel or iron or copper-free aluminum and shall be threaded. Conduit bushings shall be provided and shall be of the insulated types. Where Grounding bushings are required, provide insulated Grounding bushings with integral pressure type ground lugs.
- B. Couplings and connectors for EMT shall be made of steel or malleable iron. Die-cast products shall not be used. Connectors shall have insulated throats. Connectors and couplings shall be setscrew or compression type.
- C. Fittings for PVC 40 shall be polyvinyl chloride, installed using PVC solvent to form a watertight joint, except elbows (including bends exceeding 15°) shall be metallic. These metallic elbows

and bends shall be of the type specified in this section for the environment in which they are to be installed.

- D. Fittings for flexible metal conduit shall be steel or malleable iron only. Throats shall be insulated.
- E. Fittings for liquid-tight flexible conduit shall be steel or malleable iron, of a type incorporating a threaded Grounding cone, nylon or plastic compression ring, and a tightening gland, providing a low resistance ground connection. Throats shall be insulated.

## 2.4 CONDUIT WITH INNERDUCTS

- A. Provide innerducts in conduits, Cable Trays and underground ductbanks of the type, size and quantity shown on the Drawings or as specified.
- B. Innerducts shall be flexible ducts with the size as noted on the Drawings. Standard color shall be orange.
  - a. Multiple cell innerducts shall be installed within a four inch EMT outer conduit.
  - b. In building interior locations, provide plenum rated Carlon Plenum-Gard or Riser-Gard, as required by the installation.
- 2. Exterior locations:
  - a. Multiple cell innerducts shall be installed within a four inch PVC outer conduit.
  - b. In outdoor underground conduits, provide Carlon Corrugated HDPE, or as approved.
- C. Innerducts shall be field installable. Install all innerducts within a conduit at once, without kinking or crushing.

## PART 3 - EXECUTION

### 3.1 USES PERMITTED:

- A. Conduits shall be of the sizes shown on the Drawings or as required by the NEC, whichever is larger. Base sizes on using type XHHW for wire sizes #6 and smaller and type THHN/THWN wire for wire sizes #4 and larger. Unless otherwise noted, conduits installed in the following locations shall be of the types specifically identified only:
  - 1. Underground or encased in concrete - rigid steel or PVC-40.
  - 2. Outdoors aboveground or damp locations - RMC or extreme temperature liquid-tight flexible steel conduit (where required).
  - 3. Dry indoor locations, concealed or exposed - RMC, rigid aluminum, EMT (where not susceptible to physical damage), flexible conduit where necessary, or IMC.
  - 4. Indoor locations, exposed, where susceptible to physical damage - RMC or IMC.
  - 5. Motor and equipment flexible connections - LFMC or FMC (when installed in plenum spaces).

### 3.2 INSTALLATION METHODS - GENERAL

- A. Concealed raceways: In occupied areas, conduit and raceways shall be concealed unless specifically noted otherwise. In service spaces (mechanical equipment rooms, electrical rooms, etc.), approved raceways may be surface mounted for connection to equipment in exposed surface mounted locations.
- B. Concealed raceways shall be routed as directly as possible with a minimum of bends. Concealed raceways above lay-in ceilings shall be installed a minimum of 12 inches above the ceiling grid.
- C. Exposed Raceways: Where allowed by this Specification or specifically noted on the Drawings, raceways may be mounted on the surface of walls, ceilings and other surfaces. Exposed raceways shall comply with the following:
  - 1. Exposed raceways shall be run parallel or perpendicular to building lines and bent symmetrically or made up with standard elbows or fittings.

2. Surface-mounted conduit, junction boxes, pulls boxes, Outlet Boxes, etc. installed in finished areas shall be painted to match the surrounding surfaces.
  3. Connectors and fittings for raceways and conduits installed on the surface in exterior locations shall be suitable for and Listed for use in a wet location.
  4. Conduits installed in exterior locations shall be painted to match the exterior finish of the building surface to which they are attached. This shall include conduits attached via racks and stand-off brackets, or attached directly to the surface.
- D. Conduit and tubing shall be cut square and reamed smooth at the ends and all joints made tight. Conduit threads shall be lubricated with an approved thread lubricant.
  - E. Raceway for power wiring shall not be installed in the floor slab beneath telecommunication rooms.
  - F. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet box by means of a locknut on the outside and a locknut/bushing on the inside, or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter. All connections shall be made wrench tight. Locknuts shall be the bonding type with sharp edges and shall be installed in a manner that will assure a locking installation. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into threaded connections. Runs of conduit shall be protected from the entrance of foreign material prior to the installation of conductors.
  - G. Conduit or tubing deformed or crushed in any way shall not be installed. Conduit shall be bent only with approved bender (hydraulic or hickey). Bending machines shall be used to make field bends in conduit of 1-1/4 inch size and larger. Torches shall not be used in making conduit bends.
  - H. Raceways shall be spaced at least 6 inches from parallel runs of heating system pipes, flues, other high temperature piping systems, and other heat sources. This basic spacing shall be increased if necessary to ensure that raceways experience no significant temperature rise from external sources. Raceways shall not be embedded in any spray-applied insulation, fireproofing, or other materials that would restrict heat dissipation.
  - I. Pull wires shall be provided in all spare and unused conduits. (Nylon "jet-line" or as approved.)
  - J. Clean conduits 3-inches and larger utilizing conduit mandrels.
  - K. Conduits stubbed up out of floor and terminating inside of an enclosure shall have insulating Grounding bushings installed.
  - L. Raceways penetrating vapor barriers or traversing from warm to cold areas shall be sealed on the inside with a non-hardening duct sealing compound to prevent the accumulation of moisture, and shall be taped airtight to the vapor barrier on the outside.
  - M. Raceways (particularly PVC) shall be provided with expansion joints where necessary to allow for thermal expansion and contraction. Set initial opening of expansion joints per manufacturer's instructions, to suit the ambient temperature at the time of installation.
  - N. Provide flexible conduit connection at seismic joints to allow for displacement of conduit in all three axes. Provide appropriate lengths of flexible conduits at seismic joints and appropriate amounts of slack in conduit to allow movement of conduit/cabling in accordance with the design of the seismic joint. Slack shall be maintained in conduit after cabling is installed. Minimum lengths of flexible conduit and minimum amount of slack for various size conduits shall be as follows:
    1. 2 inch and greater: 4 foot length, 4-6 inches slack.
    2. 1-1/2 inch and smaller: 2 foot length, 3 inches slack.
  - O. Flexible metal conduit with supplemental ground jumper shall be used for connection to vibrating equipment, or where installation conditions warrant its use with express permission. Flexible conduit shall not penetrate walls. Liquid-tight flexible conduit with supplemental ground jumper shall be used for motor and transformer connections (except utilize flexible

metal conduit in plenum spaces). The ground jumper in flexible conduits shall be routed within the conduit.

- P. Length of flexible conduit shall not exceed 36 inches, except for lighting fixture whips and where specifically noted. Fixture whips shall not exceed 72 inches. Flexible conduit shall not penetrate walls.
- Q. Electrical raceways may penetrate roofing membranes only where absolutely necessary. Submit intended locations to Contracting Agency for approval prior to installation. Such penetrations shall be flashed and sealed as required for mechanical piping penetrations of roof. Where practical, conduits stubbed up to roof-mounted equipment shall be routed within the equipment curb supporting the equipment.

### 3.3 INSTALLATION METHODS - TELECOMMUNICATIONS SYSTEMS

- A. Installation methods for telecommunication system conduits shall comply with Installation Methods - General, above, unless superseded by more stringent requirements of this section.
- B. Telecommunications conduits shall comply with the requirements of TIA/EIA-569 and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual. Note that some of these requirements are more stringent than the requirements of the National Electrical Code.
- C. There shall be no more than two 90-degree bends between pull points in telecommunications conduit. Pull boxes added to conduit runs as a result of this requirement shall be in accordance with Section 26 05 37 - Pull and Junction Boxes. If it is not practical to install a pull box in the run due to field conditions, the conduit size shall be increased to the next trade size for each additional 90-degree bend. Offsets shall be considered as equivalent to a 90-degree bend.
- D. Inside radius of conduit bends shall be at least 6 times the internal diameter of the conduit for sizes up to 2 inch trade size; 10 times the internal diameter of the conduit for sizes larger than 2 inch trade size. Where bending machine shoes are not available with the required bending radius for a one-shot field bend, factory bent, large radius 90-degree elbows shall be provided.
- E. Conduits stubbed to Cable Trays shall be terminated within a maximum horizontal distance of 4 inches from the tray and in a vertical zone between 1 to 6 inches above tray. Conduits shall be supported from structure within a maximum horizontal distance of 12 inches from the tray. Conduits shall be provided with a Grounding bushing and shall be bonded to the Cable Tray with a minimum #12 AWG copper conductor.
- F. Use of flexible conduit for telecommunications shall be kept to a minimum and shall be at the discretion of the Contracting Agency. Obtain prior written approval for the use of flexible conduit. Where required due to physical considerations, flexible metal conduit may be allowed in lengths not exceeding 4 feet. If used, flexible metal conduit shall be increased by one trade size for the application used (see Conduit Sizes).
- G. Conduits entering the telecommunications room or equipment room through the floor shall be terminated 4 inches above finished floor. Conduits entering the telecommunications room or equipment room from above shall be terminated 4 inches below the finished ceiling, but in no case shall the conduits terminate greater than 12 inches above the cable pathway support or distribution frame.
- H. Conduit sleeves connecting vertically "stacked" telecommunications rooms shall be terminated 4 inches above finished floor. Conduits and cutout openings between floors shall be sealed with firestopping material that is reusable, to accommodate additions and deletions, moves and changes in the cabling system.
- I. Layout of conduits shall give consideration to nearby sources of electromagnetic energy such as electrical power wiring, large electric motors and generators, induction heaters, arc welders, variable frequency drives, etc. Maintain the greatest separation practicable between telecommunication raceways and sources of electromagnetic interference (EMI). A minimum

of 5 inches of separation shall be maintained between telecommunication raceways and fluorescent lighting ballasts.

- J. Pull wires shall be provided in spare and unused conduits. (Nylon "jet-line" or as approved.)
- K. Maintain minimum separation from < 480V power wiring in accordance with the following table:

Condition	Minimum Separation Distance		
	< 2 kVA	2-5 kVA	> 5 kVA
Unshielded power lines or electrical equipment in proximity to open non-metal telecommunications pathways	5 inches	12 inches	24 inches
Unshielded power lines or electrical equipment in proximity to a grounded metal telecommunications conduit pathway	2.5 inches	6 inches	12 inches
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal telecommunications conduit pathway	--	3 inches	6 inches

### 3.4 CONDUIT SIZES - GENERAL

- A. Minimum sizes for rigid steel, IMC, FRE, rigid aluminum and PVC-40 conduits shall be ¾ inch.
- B. Minimum size for EMT shall be ½ inch.
- C. Minimum size for flexible conduits shall be ½ inch, except fixture whips may be 3/8 inch as allowed by the NEC.
- D. Maximum size for EMT shall be 3 inch, except telecom backbone conduits may be 4 inch where shown on the Drawings.

### 3.5 CONDUIT SIZES - TELECOMMUNICATIONS SYSTEMS

- A. Minimum size for telecommunications building service entrance conduit shall be 4 inch.
- B. Minimum size for conduit runs to outlets is 1 inch.
- C. Unless indicated otherwise, individual conduit homeruns shall serve no more than one telecommunications outlet.

### 3.6 STRUCTURAL COORDINATION

- A. Layout conduits in slabs to avoid compromising structural integrity. Obtain approval from Structural Engineer for maximum conduit sizes, quantities, arrangement, and placement in structural slabs.
- B. Structural members shall not be cut, drilled, or notched for raceways or other electrical features unless specifically accepted by the Contracting Agency.
- C. Under floor raceways for slab-on-grade construction shall be embedded in the fill under the slab, not in the slab itself. Where raceways are required or permitted to be embedded in concrete, the thickness of concrete on all sides of each raceway shall not be less than 2 inches.

- D. X-ray concrete prior to core drilling. Do not cut rebar without specific authorization from the Contracting Agency. Protect existing equipment and building finishes prior to performing core drills. Replace or repair equipment and/or building finishes damaged during core drilling operations as directed by the Contracting Agency.

**END OF SECTION 26 05 34**

**SECTION 26 05 35**  
**SURFACE RACEWAYS**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Provide a complete surface metal raceway system as shown and specified including but not limited to base, cover, device fittings, entrance fittings, corners, elbows, supports, brackets, vertical and/or horizontal offsets, grounding, devices, and hardware for a complete system.

**1.2 SECTION INCLUDES**

- A. Surface metal raceways.
- B. Multi-outlets assemblies.
- C. Wireways.

**1.3 REFERENCES**

- A. NECA (National Electrical Contractors Association) Standard of Installation.
- B. NEMA WD 6 - Wiring Device Configurations.

**1.4 QUALITY CONTROL**

- A. Surface raceways shall be of the latest approved design as manufactured by a nationally recognized manufacturer and shall be listed by the Underwriters' Laboratory and bear the UL label.
- B. Perform Work in accordance with NECA Standard of Installation.

**1.5 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes (custom factory pre-painting, color as selected by Department), and accessories.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

**1.6 REGULATORY REQUIREMENTS**

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

**PART 2 - PRODUCTS**

**2.1 BASIS OF DESIGN**

- A. The Basis of Design is equipment from Wiremold, Hubbell or Mono-Systems, to set a standard for quality and style.

## 2.2 MULTI-OUTLET ASSEMBLY

- A. Divided multi-outlet assemblies shall be sheet metal channel 4 3/4 inches wide, 1 3/4 inches deep with metal divider to separate power and communications wiring compartments and fitted cover, suitable for use as surface metal raceway, Wiremold Series 4000, or as approved. Mounting fastener holes shall be factory pre-punched.
- B. Device fittings shall be suitable to accept a single or duplex standard electrical outlet or multi-telecommunication jack as specified in other Sections, Wiremold 4047, or as approved.
- C. Entrance Fittings shall accept concealed conductor entry from the back via a flush outlet box in the wall. Entrance fitting cross section shall be identical to the sheet metal channel and shall accept the same fitted cover. Entrance fitting openings shall be factory pre-punched.
- D. Finish: Multi-outlet assemblies shall be factory pre-painted a standard color as selected by the Department.
- E. Base channel mounting fastener holes shall be factory pre-punched in raceways. Provide suitable backing for mounting attachment, hollow wall anchors are not allowed.
- F. Fittings: Furnish manufacturer's standard couplings, elbows, outlet and device boxes, and connectors.

## 2.3 WIREWAY

- A. Unless otherwise noted on the Drawings, surface wireway in exposed or concealed locations shall be sheet metal channel suitable for use as a wiring trough, with hinged or screw cover, sized in accordance with the NFPA 70. Wireway shall be Square D Class 5100, 5120, 5140, as appropriate for the environment, or as approved.
- B. Wireway shall be of the NEMA Type (general purpose, oil-tight, dust-tight, rain-tight, etc.) appropriate for the environment where installed.
- C. Wireway shall be furnished without factory pre-punched concentric or eccentric conduit knockouts. Knockouts shall be field punched as required for the conduits installed.
- D. Finish shall be ANSI-49 gray epoxy paint.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Use flat-head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
- C. Provide outlets in locations shown or according to spacing specified on the Drawings. Where spacing is specified, the maximum distance from each end of the raceway to the first outlet shall not exceed one-half of the specified spacing distance. Mounting elevations shall be as noted on the Drawings or as shown on the Architectural Elevations. If a conflict exists, the elevation shown on the Architectural Elevations shall take precedence.
- D. Provide field paint touch-up with factory furnished paint to match factory pre-painted finish, for all chips, scraps, scratches, fittings and unpainted sections of the Surface Raceways and multi-outlet assemblies, after installation of all devices and covers are complete.
- E. Provide appropriate separate device finish plates for outlets and telecommunication jacks as specified in other Sections.
- F. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- G. Close ends of wireway and unused conduit openings.
- H. Ground and bond raceways, multi-outlet assemblies and wireways under provisions of Section 26 25 00 - Grounding.

**END OF SECTION 26 05 35**

**SECTION 26 05 36**  
**CABLE TRAY**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Provide a complete cable pathway support system as shown and specified including required connectors, supports, brackets, engineered seismic bracing, vertical and/or horizontal offsets, grounding and hardware for a complete system.

**1.2 REFERENCE STANDARDS**

- A. Underwriters' Laboratories, Inc.
- B. National Electrical Code.
- C. Canadian Standards Association.
- D. ANSI/EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. ASTM A 123 - Zinc (Hot Dip Galvanized Coatings on Iron and Steel Products).
- F. ASTM A 510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
- G. ASTM B 633 - Electrodeposited Coatings of Zinc on Iron and Steel.
- H. ISO 9002.

**1.3 QUALITY CONTROL**

- A. Products shall be of the latest approved design as manufactured by a nationally recognized manufacturer and shall be listed by the Underwriters' Laboratory and bear the UL label.
- B. Alternative systems to the Basis of Design will be considered providing that sufficient documentation is provided to satisfy the Department that the equipment meets the requirements of the specification.

**1.4 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**1.5 SHOP DRAWINGS**

- A. Work shall be laid out in advance. Shop Drawings shall be submitted to the Department for approval before work begins.
- B. Work under this section has been indicated on the Drawings in locations which should allow installation without interfering with the work of other trades; however, exact finish locations cannot be indicated. Therefore, locations of all work and equipment shall be verified to avoid interferences, preserve head room and keep openings and passageways clear. The Contractor shall review the plans for the work of all trades and shall coordinate adjustment of the work of the trades to achieve the best installation for the Department without additional claims or charges. Shop Drawings shall reflect coordination of work under this Section.
- C. Submit a complete pathway layout drawn at 1/8-inch = 1 foot scale minimum including suspension points, offsets, firewall penetrations and other essential information. Layout shall be coordinated with mechanical ventilation, plumbing, and fire protection Contractors to insure that the required access is unobstructed for its entire length. Locations shall be dimensioned with all obstructions shown and noted. Drawings shall include sections of corridors and of areas where obstructions require special coordination, showing the location in relation to work of other trades. Submit layout for approval.

## **PART 2 - PRODUCTS**

### **2.1 WIRE MESH TYPE CABLE TRAY**

- A. Cable tray shall be a continuous, rigid, welded wire mesh cable management system without sharp edges. Wire diameter shall be 0.177 inch (4.5 mm) minimum.
- B. All mesh sections shall have at least one (1) bottom longitudinal wire along entire length.
- C. Nominal Dimensions, unless otherwise shown on the Drawings:
  - 1. Mesh shall be in a 2 by 4 inch pattern or tighter.
  - 2. Depth: 4 inches.
  - 3. Width: 20 inches or as noted on the drawings.
  - 4. Electro-plated Zinc galvanizing (ASTM B 633, Type III, SC-1).
- D. Wire basket type cable tray shall be UL classified as an equipment Grounding conductor. Provide Grounding clip for continuous ground of cable management system.
- E. Basis of Design: Cablofil Wire Mesh, G.S. Metals Flextray or as approved.

### **2.2 J-HOOKS**

- A. No J-hooks or similar products are permitted on this Project. All telecom horizontal cable shall be routed from telecom outlet to telecom room via dedicated conduit homeruns or via dedicated conduit stubbed to cable tray.

### **2.3 ACCESSORIES**

- A. Dropouts: Provide solid bottomed cable access dropouts with adequate bend radius where bundles of cables exit the bottom of horizontal cable tray sections.
- B. Grounding and Bonding Strap: Unless otherwise noted on the Drawings, provide braided ground strap to connect discontinuous sections of cable tray, e.g., at through-wall penetrations with tray terminated on each side of wall.
- C. Divider Strip: Provide pre-manufactured divider strip to partition sections of tray as required for separation of systems, or as noted on the Drawings.
- D. Where called for on the Drawings, provide solid cable tray covers of a matching width constructed of pre-galvanized steel.

### **2.4 CABLE TRAY SUPPORTS**

- A. Center supported cable trays with hangers 12 inches or less in length, measured from the top of the cable tray to the bottom of the structural support shall be supported on maximum 12 foot centers by 1/2 inch threaded rods. Support rods shall pass through a vertical hole in the splice connector or central spine. Each tray support shall be attached by one 1/2 inch nut washer and lock washer on the top and bottom of the spine. Additional supports shall be provided at bends and tee fittings. Factory provided J-hangers, Listed for use with the tray and installed in accordance with manufacturer's instructions may be provided in lieu of through-spine rod hangers.
- B. Center supported cable trays with hangers greater than 12 inches in length, measured from the top of the cable tray to the bottom of the structural support shall be provided with additional bracing as follows:
  - 1. Each support shall be equipped with manufacturer's recommended hanger rod stiffener system.
  - 2. Transverse seismic braces shall be provided at least every 10 feet-0 inches.
  - 3. Longitudinal seismic braces shall be provided at least every 20 feet-0 inches.
  - 4. Seismic supports shall be sized to accommodate the tray being fully loaded with cables.
- C. Seismic supports and bracing shall be in accordance with Section 26 05 29 - Hangers and Supports and Section 13 48 00 - Vibration and Seismic Control, and the manufacturer's

engineered solution for the project's seismic zone. Where required or recommended by the tray manufacturer, the Contractor shall employ the services of a licensed Structural or Seismic Engineer to design the seismic bracing for the specific seismic zone requirements.

- D. Wall Spacers: Factory provided wall spacers shall be provided between wall mounted cable tray spine and mounting surface to maintain space for rung ends extending through spine. Provide supports at intervals in accordance with manufacturer's requirements.

## 2.5 FIRE RATED ASSEMBLY PENETRATIONS

- A. Provide permanent fire stop system at all through penetrations of fire rated wall, floor and roof assemblies which meet the evaluation criteria set forth in ASTM Standard E-814 and UL Standard 1479 for fire tests of through penetrations.
- B. Fire stop materials, assemblies and installations shall be approved by Factory Mutual and shall be as published in the latest edition of the Underwriters Laboratories Fire Resistive Directory. Firestop Systems provided shall be acceptable to the Authority Having Jurisdiction.
- C. Penetration seal methods and materials shall have an Underwriters Laboratories fire rating equal to the wall or floor in which the openings are located. The penetration seal must allow future changes, such as addition or removal of cables, with no damage to the integrity of the seal. If the wall or floor penetration is for cable tray passage, the fire stop material shall have been tested by Underwriters Laboratories for use with both galvanized steel and/or aluminum cable tray. The penetration seal must be unaffected by atmospheric conditions, water exposure, or constant high humidity. The fire seal shall be installed strictly according to the manufacturer/distributor published instruction.
- D. Submit Shop Drawings showing detailed construction of the through-penetration fire stop system, with reference to the UL Fire Resistance Directory System Number.
- E. Unless otherwise submitted by the Contractor and approved by the Department, through wall penetration assemblies shall consist of metallic sleeves inserted into the wall opening with a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall automatically adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or re-install fire-stop materials.
- F. Provide number of pathway devices to accommodate all cables with an additional 15% spare capacity in each device. Provide one entirely spare pathway device, unless otherwise noted.
- G. Unless otherwise submitted by the Contractor and approved by the Department, floor through penetration assemblies shall consist of reusable frame-type multi-cable transit assemblies. Cable tray shall stop at or near the upper and lower surfaces of the floor assembly and a blocked out opening shall be provided for cable transit assembly. Separate grooved insert modules constructed of fire stop material shall be provided for each cable, sized for the cable diameter, and inserted into a bolted down compression frame.
- H. Equipment: STI EZ Path Fire Rated Pathway, or as approved.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. The Contractor shall proceed with the installation only after Shop Drawings are approved by the Department. If the Contractor proceeds without approval, relocation as directed by the Department shall be at the Contractor's expense.
- B. Install pathways level, straight and true to building lines, unless otherwise noted on Drawings or required due to structural considerations or obstructions.
- C. Cable tray clearances:
  - 1. Maintain 12 inches minimum clearance above top of cable tray. Maintain 3 inches minimum clearance between top surface of ceiling tiles and lowest point on cable tray or

cable tray support assembly. Maintain 6 inches minimum clearance to all sides of tray unless tray is placed at a height which requires greater clearance for workers to gain safe, convenient access to tray. Coordinate layout with work of other trades in advance of installation to provide required access with minimum number of offsets in cable tray runs.

- D. If during construction as-built conditions occur, such that cable tray becomes inaccessible for any reason, Contractor shall submit immediately to the Department:
  - 1. The type and location of the obstruction, including the trades involved.
  - 2. The means proposed by Contractor to maintain accessibility.
- E. Install all cable trays in an accessible location, visible from the floor, with minimum length hanger rods to avoid cable tray tilting under eccentric loads. If tray tilts at any location, provide 1-1/2 inch pipe in compression over hanger rods, a bar stiffener at hanger rods, or other manufacturer recommended anti-tilt method of mounting tray. Provide stiffener bar at every other support, or in accordance with manufacturer's recommendations.
- F. Install and support cable tray systems in accordance with span load criteria, assuming 110% of maximum allowable cable-fill regardless of the number of cables installed under this Contract.
- G. Install cable tray to prevent sharp 90 degree bends in cables in any direction. Rises and drops shall be radiused, tees and crosses shall be flared or have radius fittings at junction points.
- H. Seismic supports and bracing shall be in accordance with Section 26 05 29 - Hangers and Supports, Section 13 48 00 - Vibration and Seismic Control, and the manufacturer's engineered solution for the project's seismic zone.
- I. Center hung supports and center support tubes shall run full length of the rod to the structure. Tighten rod to place assembly in tension. Center supports suspended by rods shall have sufficient protective tubing over all exposed all-thread to protect the cable insulation from abrasion.
- J. Cable tray arranged in vertical configuration for rises and drops shall have stand-off support from the wall or structural support surface the facilitate installation of cable support ties. Secure cables in trays with cable ties in accordance with the manufacturer's recommendations.
- K. Unless otherwise noted on the Drawings or allowed in the Specifications, above ceiling cable tray installations shall meet the following conditions:
  - 1. Cable trays shall not be installed in inaccessible ceiling areas such as those with lock-in type ceiling tiles.
  - 2. Cable trays shall not be installed above lay-in type ceilings at a finished height greater than 11 feet above finished floor.
- L. Unless otherwise noted on the Drawings, install cable tray and all accessories to provide electrical continuity throughout system. Provide Grounding and bonding straps to maintain electrical continuity at discontinuous connections.
- M. Follow manufacturer's instructions and details for separation of dissimilar metals including steel suspension rod to aluminum splice connectors or cable tray. Provide nylon bushings at joints, vinyl sleeve at hanger rods.
- N. Conduit Entries:
  - 1. Open cable tray: Conduits entering open cable trays shall terminate above the tray, within 3 inches laterally and 2 inches vertically of the top of the side rail. Conduits shall be bushed and supported within 6 inches of the termination. Provide a bonding connection from the conduit to the tray system.

- O. Coordinate installation of cable tray with cable installers for purposes of symmetric cable loading, supplemental bracing in cases where cable loading will be asymmetric, periodic tie down of cables, and division of tray to maintain required separation of systems.

**END OF SECTION 26 05 36**

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**SECTION 26 05 37  
PULL AND JUNCTION BOXES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general provisions, products and methods of execution relating to Pull and Junction Boxes approved for use on this project. Furnish all such boxes, whether shown or not, in order to conform to requirements for maximum pulling length and maximum number of bends allowed.

**1.2 QUALITY CONTROL**

- A. Pull and junction boxes 50 cubic inches and smaller shall conform to specifications for Outlet Boxes, Section 26 05 33 - Outlet Boxes.
- B. Pull and junction boxes larger than 50 cubic inches shall conform to U.L. Standard 50, Cabinets and Boxes. The UL label shall constitute proof of acceptable quality.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**PART 2 - PRODUCTS**

**2.1 INDOOR PULL AND JUNCTION BOXES**

- A. Indoor Pull and Junction Boxes shall conform to Article 314 of the NEC and the following requirements:
1. Sheet metal boxes are approved for use in all dry, interior, nonhazardous locations.
  2. Boxes installed in wet locations shall be NEMA 3R, unless otherwise noted.
  3. Special boxes, as noted on the Drawings, shall be installed in areas of specific service and/or hazards.
- B. Junction box extension rings will not be accepted on new boxes. Appropriate size boxes shall be used for each application.

**2.2 TELECOMMUNICATION SYSTEM PULL BOXES**

- A. Telecommunication system Pull Boxes shall also conform to ANSI/EIA/TIA 569 and the BICSI Telecommunications Distribution Methods (TDM) Manual.
- B. Dimensions:
1. Pull boxes for straight through pulls shall have minimum interior dimensions in accordance with the following Table:

Maximum Trade Size Conduit	Size of Box			For Each Additional Conduit Increase Width
	Width (inches)	Length (inches)	Depth (inches)	
1 Inch	4	16	3	2 inches
1 1/4 Inch	6	20	3	3 inches
1 1/2 Inch	8	27	4	4 inches
2 Inch	8	36	4	5 inches
2 1/2 Inch	10	42	5	6 inches
3 Inch	12	48	5	6 inches

3 1/2 Inch	12	54	6	6 inches
4 Inch	15	60	8	8 inches

**2.3 TELECOMMUNICATION SYSTEM SPLICE BOXES**

- A. Unless otherwise specified or noted on the Drawings, splice boxes shall not be used in interior horizontal pathway conduits or interior backbone pathway conduits.
- B. Where required in a building service entrance or campus backbone pathway system, splice boxes shall be provided in accordance with the requirements of ANSI/EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual.

**2.4 UNDERGROUND PULL AND JUNCTION BOXES**

- A. Boxes set in ground shall be either precast concrete or cast iron. Covers shall be galvanized steel or cast iron, and shall be bonded to the grounding system with a stranded grounding conductor secured with a grounding lug. Provide sufficient slack to allow removal of the cover and normal working access.
- B. Underground concrete pull boxes installed in traffic areas shall be constructed to withstand AASHTO HS-20 wheel loading.

**2.5 OUTDOOR ABOVE-GROUND PULL AND JUNCTION BOXES**

- A. Boxes exposed to rain or installed in wet locations shall be NEMA 4X unless otherwise noted.
- B. Outdoor Pull and Junction Boxes and conduit bodies for use with galvanized conduits shall be made of galvanized ferrous metal or cast aluminum, with integral threaded hubs or Myers-type weather tight hubs of matching composition and finish.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Junction and pull boxes shall be installed so that covers are readily accessible and adequate working clearance is maintained after completion of the installation.
- B. Select boxes properly sized per NEC for power and lighting applications.

**3.2 TELECOMMUNICATIONS SYSTEM PULL BOXES**

- A. Where a pull box is required in a 1 inch conduit run, Outlet Boxes as specified in Section 26 05 33 - Outlet Boxes may be used. Where a pull box is required in a conduit run 1 1/4 inch or larger, or where required for multiple raceways, the box shall be sized in accordance with the Table in this Section.
- B. Pull boxes shall be located in straight-through sections of horizontal cabling pathways (conduits). Pull boxes shall not be used for angle pulls or to accomplish changes in direction of the pathway.
- C. Multiple raceways connecting to telecommunications system pull boxes shall penetrate box walls such that they are distributed evenly along the Box wall.

**3.3 TELECOMMUNICATIONS SYSTEM JUNCTION BOXES**

- A. Telecommunications system interior pathways shall not contain junction boxes.

**END OF SECTION 26 05 37**

**SECTION 26 22 00**  
**SECONDARY TRANSFORMERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general provisions, products, and methods of execution relating to transformers approved for use on this project. Type, size, ratings, etc., shall be as shown on the plans and in accordance with UL and NEMA standards.
- B. Include all power and control transformers through 600 volts in this and other Divisions of specifications, including items such as: Control, communications systems, lighting and power, distribution and signal systems transformers, whether furnished as an integral component of an item of equipment or separately provided.

**1.2 QUALITY CONTROL**

- A. Transformers shall be of the latest approved design as manufactured by a nationally recognized manufacturer and be listed in the Underwriters' Laboratory and bear the UL label.
- B. Transformers shall perform in accordance with applicable NEMA standards and shall be installed in accordance with the National Electric Code.
- C. The Basis of Design is equipment from Square D Company to set a standard for quality. Equipment from Cutler Hammer, Siemens Energy & Automation, General Electric or alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the specification.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Submit for approval manufacturers shop drawings to show weights, dimensions, mounting arrangements, interconnecting diagrams, and electrical power requirements. Furnish typical test data, including ratio, resistance, losses, sound level, applied voltage, induced voltage, temperature rise, impulse test, impedance, X/R ratio, efficiency, transient inrush current and short circuit test.

**PART 2 - PRODUCTS**

**2.1 TRANSFORMERS**

- A. All transformers shall be dry-type.
- B. Three phase transformers shall be 480 volt delta primary and 208 wye volt secondary. Transformers 25 KVA and larger shall have a minimum of 4-2 1/2% full capacity primary taps (2 above normal and 2 below) unless otherwise noted.
- C. Transformers 15 KVA and larger shall be rated 115°C temperature rise above 40°C ambient, unless otherwise indicated on the Drawings. The transformer shall be listed by Underwriters' Laboratory for the specified temperature rise. Insulating materials shall be in accordance with NEMA ST20-1972 standards for a 220°C UL component recognized insulation system.
- D. Transformer coils shall be of continuous wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish.
- E. Cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below the saturation point under all conditions of possible load. The core laminations shall be clamped together with structural steel angles. The complete core and coil

shall then be bolted to the base of the enclosure but isolated there from by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. On transformers 500 KVA and smaller, the vibration isolating system shall be designed to provide a permanent fastening of the core and coil to the enclosure. Sound isolating systems requiring the complete removal of all fastening devices are not acceptable.

- F. Transformers 15 KVA and larger shall be in a heavy gauge, sheet steel, ventilated enclosure. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code standards for ventilated enclosures. Single phase transformers 15 KVA through 167 KVA, and three phase transformers through 112.5 KVA shall be designed so they can be either floor or wall mounted. Larger transformers shall be designed only for floor mounting.
- G. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
- H. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible Grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.
- I. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished with gray, baked enamel.

## 2.2 SOUND RATINGS

- A. Sound levels shall be guaranteed by the manufacturer not to exceed the following:
  - 1. 15 to 50 KVA: 45dB.
  - 2. 51 TO 150 KVA: 50dB.
  - 3. 151 TO 300 KVA: 55dB.
  - 4. 301 TO 500 KVA: 60dB.
- B. Replace transformers deemed excessively noisy by the Contracting Agency at no additional contract cost.

## 2.3 TRANSIENT INRUSH CURRENT

- A. Primary overcurrent protection for dry type step down transformers is based on Basis of Design manufacturer's published data for transient inrush current. If transformers submitted have higher inrush currents that require upsizing of circuit breakers, conduits, conductors, etc., the cost of these changes shall be borne by the Contractor. Basis of design inrush currents are as follows:

Transformer kVA	Transient Inrush Current (multiplier times full load current)
30	9.6
45	8.7
75	10.1
112.5	7.9
150	9.4
225	9.8
300	11.6
500	11.6

- B. If transient inrush current exceeds that of the specified transformers a complete coordination study shall be included with the Submittals for the affected portions of the electrical systems, and all affected components (circuit breakers, conduits, conductors, etc.) shall be resized accordingly. Costs of changes due to higher inrush currents shall be borne by the Contractor.

**2.4 EFFICIENCY**

- A. Transformers shall have rated minimum efficiencies in accordance with NEMA TP 1-2002 per the table below when operated at 35% of full capacity.

Single-Phase		Three-Phase	
KVA	% Efficiency	KVA	% Efficiency
15	97.7	15	97
25	98	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98
75	98.5	112.5	98.2
100	98.6	150	98.3
167	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
---	---	750	98.8

**2.5 "K" FACTOR**

- A. Transformers shall have a "K" factor as indicated on the "Power One Line". Transformers with a "K" factor of 13 or greater shall withstand 100% loading at 60 Hz, 33% of the fundamental at third harmonic current, 20% of the fundamental at the fifth harmonic current, and so on (harmonic amplitude = 1/f times fundamental for all odd-order harmonics).

**2.6 SHIELDING**

- A. Transformers with a "K" rating greater than one and other transformers as specifically noted on the Drawings shall be supplied with a quality, full width electrostatic shield resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:

Common Mode:	0 to 1.5Hz - 120db; 1.5 to 10kHz - 90db; 10 to 100kHz - 65db; 100kHz to 40db.
Transverse Mode:	1.5 to 10kHz - 52db; 10 to 100kHz - 30db.

**PART 3 - EXECUTION**

**3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

**3.2 MOUNTING**

- A. Provide required structural provisions including floor, wall brackets, or trapeze suspended from structural members as indicated on drawings, or approved.
- B. Transformers up to 100 kVA: Mount transformers on double-deflection neoprene-in-shear isolators (no harder than 50 durometer) sized for the following static deflections:
1. 0.2" static deflection for slab on grade installations.
  2. 0.5" static deflection for other than slab on grade installations.
  3. Mason Industries or as approved.

- C. Transformers over 100 kVA: Mount transformers on floor mounted spring isolators with seismic snubbers sized for the following static deflections:
  - 1. 0.5" static deflection for slab on grade installations.
  - 2. 0.75" static deflection for other than slab on grade installations.
  - 3. Mason SSLF with Z-1011 seismic snubbers, Mason SLR with integral snubbers, or as approved.

### 3.3 CLEARANCES

- A. Required clearances for transformers with ventilating openings shall be in accordance with the manufacturer's requirements.

### 3.4 ADJUSTMENT

- A. Adjust transformer taps to provide rated voltage at the secondary bus with all connected loads "on", except the no-load secondary line-to-neutral voltage shall not exceed 125 volts on nominal 120 volt phases. Submit log of final voltage and current readings at no load and full load.

### 3.5 ELECTRICAL CONNECTIONS

- A. For transformer connections that are not routed under slab, the following wiring methods shall be utilized:
  - 1. Transformer mounted in space used for environmental air (e.g. fan room): Flexible metal conduit (FMC) with supplemental ground jumper.
  - 2. Transformer mounted in all other areas: Liquid-tight flexible metal conduit (LFMC) with supplemental ground jumper.
- B. The flexible conduit shall be installed in a slack, shallow "U" form and shall prevent rigid contact between the transformer components and the nearby structure, conduits, etc.

### 3.6 GROUNDING AND BONDING

- A. Transformer wye secondaries shall be grounded as separately derived systems as specified in Section 26 25 00 - Grounding.
- B. Transformers and conduits shall be bonded per NEC requirements.

**END OF SECTION 26 22 00**

**SECTION 26 24 00  
DISCONNECTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general requirements, products, and methods of execution relating to fusible and non-fusible disconnecting devices approved for use on this project.

**1.2 QUALITY CONTROL**

- A. Devices shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with U.L. listings and the governing NEMA standards.
- B. Disconnects shall be of the same manufacturer as switchboards and Panelboards.

**1.3 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**PART 2 - PRODUCTS**

**2.1 SAFETY SWITCHES**

- A. Safety switches, fusible and non-fusible, shall conform to NEMA Standard KS1 for type HD (Heavy Duty) unless otherwise noted.
  - 1. Switch Interior: Switches shall have switch blades that are fully visible in the OFF position when the door is open. Switches shall be of dead-front construction with permanently attached arc suppressers. Lugs shall be UL listed for copper and/or aluminum cables and be front removable.
  - 2. Switch Mechanism: Switches shall have a quick-make and quick-break operating handle and mechanism that shall be an integral part of the box, not the cover. Switches shall have a defeatable dual cover interlock to prevent unauthorized opening of the switch door in the ON position or closing of the switch mechanism with the door open. The switch shall be capable of being locked in the OFF position with three (3) padlocks.
  - 3. Enclosures: Switch enclosure shall be suitable for the environment in which the switch is mounted. NEMA 1 enclosure shall be code gauge, UL-98, sheet steel, treated with a rust inhibiting phosphate and finished in gray, baked enamel. NEMA 3R enclosure--same requirements as NEMA 1 except galvanized prior to Painting. NEMA 4X for exterior locations.
  - 4. Rating: Ampere, volt and horsepower ratings, as well as number of poles and presence of neutral bar shall be shown on the name plate.

**2.2 CIRCUIT BREAKERS**

- A. Circuit breakers used as Disconnects shall meet requirements specified in Section 26 26 20 - Overcurrent Protective Devices. Enclosures for same shall meet the requirements as specified above.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Coordinate details pertaining to size of motor and/or equipment, location and requirements to enclosure, ratings, etc., so as to provide the most suitable unit for the intended purpose.
- B. Provide nameplates for Disconnects. Coordinate names with mechanical equipment lists.

- C. Where the ratings of a fused disconnect exceeds the ampacity of the conductors being protected, a permanent label noting maximum fuse size shall be installed in a conspicuous location within the switch.
- D. Where recommended or required by the equipment manufacturer, or required by underwriters' laboratories, Disconnects shall be the fusible type, fused in accordance with the equipment nameplate information.
- E. Provide all code-required Disconnects. For equipment which is under the jurisdiction of the IMC, a disconnect shall be provided within sight of the equipment.

**END OF SECTION 26 24 00**

**SECTION 26 24 16  
PANELBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general provisions, products, and methods of execution relating to branch circuit Panelboards approved for use on this project. Type, size, ratings, etc., shall be as shown on the plans and in accordance with UL Standards 50 and 67.

**1.2 SPECIAL REQUIREMENTS**

- A. Special features such as integral Surge Protective Devices (SPDs), etc., shall be provided as required by this Section and as noted on the Drawings or on the panel schedules.
  - 1. Trims shall be furnished to be compatible with type of mounting.
  - 2. "Door-in-door" construction shall be furnished on Panelboards unless otherwise noted.

**1.3 QUALITY CONTROL**

- A. The Panelboards shall be of the latest approved design as manufactured by a nationally recognized manufacturer and be listed in the Underwriters' Laboratory and bear the UL label.
- B. The Basis of Design is equipment from Square D Company to set a standard for quality. Equipment from Cutler-Hammer, Siemens Energy & Automation, General Electric, or alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

**1.4 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 and Division 1.
- B. Submit for approval manufacturer's shop drawings to show weights, dimensions, mounting arrangements, interconnecting diagrams, schedules of all overcurrent devices, voltage ratings, and all specified accessories.

**PART 2 - PRODUCTS**

**2.1 CABINETS AND FRONTS**

- A. Panelboard assembly shall be enclosed in a steel cabinet. Fronts shall include doors and have flush, brushed stainless steel, cylinder tumbler-type locks with catches and spring-loaded door pulls. All panelboard locks shall be keyed alike. Fronts shall have adjustable, indicating trim clamps that shall be completely concealed when the doors are closed. Doors shall be mounted by completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. The directory card shall provide a space at least 1/4 inch high by 3 inch long or equivalent for each circuit. The directory shall be typed to identify the load fed by each circuit. Fronts shall be of code gauge, full finished steel with rust-inhibiting primer and baked enamel finish. Cabinets shall be labeled in accordance with the Drawings and Section 26 00 00.

**2.2 SAFETY BARRIERS**

- A. The panelboard interior assembly shall be dead front with panelboard front removed.

### **2.3 BUS ASSEMBLY**

- A. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Bus structure shall allow 1, 2 and 3-pole breakers of various frame sizes to be mounted in any location and in any combination up to the capability of the panel.

### **2.4 SHORT CIRCUIT CURRENT RATING**

- A. Each panelboard, as a complete unit, shall have a short circuit current rating (SCCR) equal to or greater than that shown on the panelboard schedule, or as necessary to comply with the requirements stated on the power one-line diagram. The SCCR rating shall not, in any case, be less than 10,000 Amps at 240 volts, and 14,000 Amps at 480 volts.

### **2.5 PROTECTION DEVICES**

- A. Circuit breakers shall individually comply with Section 26 26 20 - Overcurrent Protective Devices. The type to be furnished shall be as shown on the plans. If no withstand rating is specified, minimum requirements shall be as necessary to comply with the preceding requirements.

### **2.6 NEUTRAL TERMINAL BAR**

- A. All Panelboards shall be equipped with an insulated neutral terminal bar.

### **2.7 EQUIPMENT GROUNDING TERMINAL BAR**

- A. All Panelboards shall be equipped with an equipment Grounding terminal bar to terminate equipment Grounding conductors.

### **2.8 HANDLE LOCK-OFF EQUIPMENT**

- A. Circuit breakers serving as the required disconnecting means for appliances or other equipment shall be equipped with equipment to allow the breaker to be padlocked in the "off" position.

### **2.9 INTEGRAL SPDS**

- A. Provide Panelboards with integral SPDs as noted on the panel schedules or drawings in accordance with Specification Section 26 26 10 - Surge Protective Devices (SPDs).
- B. Integral SPDs shall be factory installed in the panelboard.

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 INSTALLATION**

- A. Verify mounting arrangements for each location shown on the plans. Where cabinets are recessed, verify adequate thickness of wall and make arrangements for furring or trim as required. In general, all conduits shall enter the top or bottom of panel.
- B. Provide additional wire gutters or pull boxes to facilitate orderly entry of conduits into cabinets. Bundle and support wires and arrange them in an orderly manner in the designated wire gutters.
- C. Panelboards shall not be used for pull boxes for wiring not terminating in the panelboard.

### 3.3 SPARE CONDUITS

- A. Provide spare conduits from flush mounted panels into accessible ceiling or floor spaces as follows:

No. of Poles (Spares + Spaces)	Spare Conduits
1 - 3	One 3/4 inch
4 - 6	Two 3/4 inch
7 or more	Two 3/4 inch, One 1 inch

### 3.4 PANELBOARD LABELS

- A. In addition to applicable NEC requirements for emergency systems, series rated applications, etc., label Panelboards in accordance with Section 26 00 00.
1. First line shall be panelboard name.
  2. Second line shall be voltage and phase.
  3. Third line shall indicate if panelboard is "NORMAL" (black background) or "EMERGENCY" (red background).

**END OF SECTION 26 24 16**

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**SECTION 26 25 00**  
**GROUNDING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general requirements, products and methods of execution relating to the furnishing and installation of a complete grounding system as required for this project.

**1.2 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1. Include copies of all catalog cuts, data sheets and other descriptive information for all specified materials.

**1.3 MINIMUM REQUIREMENTS**

- A. The minimum requirement for the system shall conform to Article 250 of the NEC.

**1.4 SPECIAL REQUIREMENTS**

- A. Unless specified elsewhere, the ohmic values for grounds and grounding systems shall be as follows:
1. For Grounding metal enclosures and frames for electrical and electronically operated equipment--5 ohms maximum.
  2. For Grounding systems to which electrical utilization equipment and appliances are connected--5 ohms maximum.
  3. For Grounding secondary distribution systems, neutrals, noncurrent carrying metal parts associated with distribution systems, and enclosures of electrical equipment not normally within reach of other than authorized and qualified electrical operating and maintenance personnel -- 10 ohms maximum.

**1.5 TELECOMMUNICATIONS GROUNDING SYSTEM**

- A. Telecommunications ground systems shall be provided as shown on the Contract Drawings and as related herein.
1. Telecommunication Bonding Backbone (TBB) - A copper conductor extending from the telecommunications main Grounding busbar (TMGB) to each telecommunications grounding busbar (TGB).
  2. Telecommunications Main Grounding Busbar (TMGB) - The TMGB serves as a dedicated extension of the building Grounding electrode system for telecommunications infrastructure. The TMGB is generally located in the main telecommunications entrance room or as shown on the Drawings.
  3. Telecommunications Grounding Busbar (TGB) - A busbar placed in a convenient and accessible location in a Telecom Room (TR) that is connected back to the TMGB. Equipment served from the TR shall be connected to the local TGB.
  4. Site Grounding system - connecting the TMGB in each structure to the low resistance earth grounding system.

**1.6 REFERENCE CODES AND STANDARDS**

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only, latest edition.

NUMBER	TITLE
ANSI/IEEE C2	National Electrical Safety Code

NUMBER	TITLE
ANSI/NFPA 70	National Electrical Code
ANSI/TIA/EIA 606-A	Administration Standard for Commercial Telecommunications Infrastructure
ANSI/TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications
IEEE C62.41	Recommended Practice on Surge Voltages in Low-Voltage Surge Protective Devices
IEEE C62.42	Guide for the Application of Gas Tube Arrester Low-Voltage Surge Protective Devices
IEEE Draft P1250 (D4)	Guide on Service to Equipment Sensitive to Momentary Voltage Disturbances
IEEE Std 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
IEEE Std 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE STD 81	Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth
NFPA 70	National Electric Code (NEC) - Codebook and Handbook
REA PE-33	(1985) Shield Bonding Connectors
UL 1449 Edition 3	Surge Protective Devices (SPDs)
UL 467 Edition 6	Grounding and Bonding Equipment
UL 497 Edition 5	Protectors for Paired Conductors for Communication Circuits
UL 497A Edition 1	Secondary Protectors for Communication Circuits
UL 497B Edition 1	Protectors for Data Communication and Fire Alarm Circuits

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

- A. Grounding conductors, ground rods, and equipment required for ground systems shall be listed for the purpose intended and approved by a Nationally Recognized Testing Laboratory (NRTL), and be in accordance with U.L. 467 and as follows:
1. Ground rods shall be 3/4 inch by 10 foot copper-clad steel.
  2. Grounding conductors shall be copper. Unless specified otherwise, raceway for service grounding conductor shall be Schedule 40 PVC.
  3. Grounding conductor for telephone service entrance and telephone/data panels shall be #6 insulated copper, with 6 feet-0 inches slack cable at each panel. Comply with inter-system bonding requirements of NEC.
  4. Grounding conductor for television and radio distribution systems shall be #6 AWG insulated copper. Comply with intersystem bonding requirements of NEC.

### 2.2 CONNECTIONS

- A. Joints in grounding conductors and mats below grade shall be made with exothermic welding process or hydraulically-crimped fittings listed for direct burial. Terminations above grade shall be made with solderless lugs, securely bolted in place.
- B. Clamps, lugs, connectors, bonding bushings, and all other such grounding and bonding items shall be:

1. Labeled or listed for the purpose.
2. Shall be made (both body and hardware) of hot-dip galvanized steel, bronze, or other corrosion-resistant alloy (except bushing throats shall be plastic).
3. Shall be the products of O-Z/Gedney, T & B, Raco, or accepted equals.
4. In outdoor, damp, or corrosive environments, metals for these items shall be copper (with or without tin-plating), bronze, or other corrosion-resistant alloys only; O-Z/Gedney or accepted equal.

### **2.3 TELECOMMUNICATIONS GROUNDING SYSTEMS**

- A. Telecommunications Bonding Backbone (TBB):
  1. The TBB shall be a green #2 AWG minimum or size as noted on the drawings, 600 volt insulated copper conductor. The minimum size of each TBB shall be such that the total DC resistance back to the TMGB is less than  $0.10\Omega$ .
  2. Cable supports shall be strut with distribution rings.
- B. Grounding Busbars shall be Cadweld P/N B544A028, 1/4 inch by 4 inches by 16 inches copper with lug patterns for #8 through 1000 KCMIL conductors. Grounding busbars shall be electrolytic copper and mounted on fiberglass insulators rated at 2,700V.
  1. Provide one Grounding Busbar for each:
    - a. Telecommunications Main Grounding Busbar (TMGB).
    - b. Telecommunications Grounding Busbar (TGB).

### **2.4 TELECOMMUNICATIONS SYSTEM BONDING**

- A. Bond telecommunication equipment chassis, ladder racks, Cable Trays, conduits, equipment frames, cabinets, and other telecommunication room and equipment room metallic components to a local TGB with green #6 AWG, 600 volt, insulated copper conductor.
- B. Bonding of grounding conductors shall be with the following methods as specified herein:
  1. Connections to grounding busses: Cool Amp Plating, field applied to both surfaces for all bolted and compression connections.
    - a. Approved gas tight two hole copper Grounding compression lugs T&B 54205 series 2 hole, crimp Cool Amp plated compression type for connection to grounding busses.
    - b. Fasteners shall be nickel plated steel nuts, bolts and lock washers.
  2. Conductor splices and connection to ground rods:
    - a. Cadweld exothermic welds. All bonds below grade shall be exothermic.
    - b. Burndy type "YG" extruded wrought copper prefilled with Pentrox heavy duty compression connectors with probe holes (Type YGA and YGS not acceptable).
- C. Connections made to static dissipative tile grounding systems shall be made per the manufacturer's recommendations. Route grounding conductors in approved conduits.

### **2.5 IDENTIFICATION AND LABELING**

- A. Grounding conductors shall be labeled in accordance with TIA/EIA-606-A.

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 SERVICE GROUND**

- A. Create an equipotential plane for the grounding system for this project at the service entrance equipment by connecting the following to the service entrance ground bus:

1. The commercial system's grounded neutral conductor and, if installed, the stand-by generator frame.
  2. All metallic water services to the building.
  3. All grounds specified to be installed.
  4. The service entrance equipment and conduits entering and leaving the equipment.
  5. The metallic piping systems in the building.
  6. The metallic gas piping system upstream from the equipment shutoff valve.
  7. Concrete encased electrode, "Ufer ground," as further specified in this Part.
  8. Structural steel columns as noted elsewhere in this section.
  9. Other items or equipment called for on the Drawings.
- B. Ground the Emergency Generator in accordance with the requirements for a "Separately Derived System." (The transfer switches also switch the neutral.)
- C. Current carrying capacity of the grounding and bonding conductors shall be in conformity with Table 250.66 of the NEC. Exception: The bonding conductor for metallic gas piping shall be sized in accordance with Table 250.122 based on the largest overcurrent device protecting feeder conductors exiting the main Distribution Switchboards.
- D. Measure resistance to earth of service grounds by the fall of potential method per IEEE STD 81 "Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth". Record test readings.

### **3.3 EQUIPMENT GROUND**

- A. The raceway system shall be bonded in conformity with NEC requirements to provide a continuous ground path. Where required by Code or Ordinance or where called for on the plans an additional grounding conductor shall be provided, sized in conformity with Table 250.122 of the NEC, unless larger size is noted.
- B. Provide separate grounding conductor securely bonded and effectively grounded to the enclosures at both ends of all non-metallic raceways and all flexible conduit.
- C. Provide an equipment grounding conductor sized in conformity with Table 250.122 of the NEC, unless larger size noted, for feeder and branch circuit conduits. Where conductors are adjusted in size to compensate for voltage drop, equipment grounding conductors shall be adjusted proportionately according to circular mil area.

### **3.4 CONCEALED CONNECTIONS**

- A. Permanent grounding connections, where permitted by the NEC to be concealed, shall not be so concealed until inspected and accepted by the Contracting Agency. Failure to comply with this requirement will make the Contractor liable for any expenses incurred in the process of re-exposing the connections for inspection, and subsequent repair and patching of the concealing construction, including the work of other trades. The Contractor shall schedule inspection of such connections at least one work week in advance of concealment, and will not be entitled to any additional compensation or time extension for delays caused by inability of the Contracting Agency's representative to be available at the desired time.

### **3.5 CORDS AND NONMETALLIC CABLES**

- A. Unless specifically permitted otherwise, all cords and nonmetallic cables shall be furnished with integral Code sized grounding conductor. Securely bond all metal components and effectively ground the entire electrical system.

### **3.6 ELEVATOR EQUIPMENT**

- A. Provide a Code sized ground conductor to the elevator equipment in accordance with "Safety Code For Elevators and Escalators", ANSI/ASME A17.1.

### 3.7 TELECOMMUNICATIONS GROUNDING SYSTEM

- A. Service Ground:
  - 1. Provide connection to the electric power service ground. The Main Grounding Conductor from the TMGB shall be as shown on the Drawings.
  - 2. Measure resistance to earth of service ground as described in Part 3.
- B. Telecommunications Bonding Backbone (TBB):
  - 1. Connect the TBB between each TGB and the TMGB in a star configuration to minimize ground loops.
- C. Telecommunications Main Grounding Busbar (TMGB):
  - 1. Equipment and metallic raceways located in the same room as the TMGB shall be bonded to the TMGB.
  - 2. TBB connections to the TMGB shall be made with listed 2 hole compression connectors or exothermic type welded connections.
  - 3. Where a panelboard for telecommunications is located in the same room as the TMGB, the Panelboards Alternating Current Equipment Ground (ACEG) bus or the enclosure shall be bonded to the TMGB.
  - 4. Connect the TMGB to the service entrance ground bus with Cadwelded connections.
- D. Telecommunications Grounding Busbar (TGB):
  - 1. Equipment and metallic raceways located in the same room as the TGB shall be bonded to the TGB.
  - 2. TBB connections to the TGB shall be made with listed 2 hole compression connectors or exothermic type welded connections.
- E. Bonding and Connections:
  - 1. General:
    - a. Cadweld or braze concealed or below grade connections and at ground rods.
    - b. Compression connections shall be made using a hydraulic 4 way compression die.
    - c. Compression connections shall be exposed.
    - d. Insulated wire splices shall be insulated with preformed wire covers.
  - 2. To Building Steel:
    - a. Cadweld connections to building steel.
- F. Identification and Marking:
  - 1. Show conductors on neatly marked record drawings. Submit to the Contracting Agency.
  - 2. Grounding conductors shall be marked per ANSI/TIA/EIA 606-A and as directed by the Contracting Agency. Mark each cable end using tie wrap style cable markers.

### 3.8 EXTERNAL BONDING JUMPERS

- A. Not permitted; bonding jumpers shall be run inside the raceways for the circuits they serve.

### 3.9 CONCRETE-ENCASED ELECTRODES, "UFER GROUNDS"

- A. Concrete-Encased Electrodes, "Ufer Grounds", and shall be installed in accordance with NEC 250.52(A).
- B. Unless otherwise noted, Ufers shall be installed in the concrete footing closest to the electrical main service equipment and in the concrete footing closest to electrical rooms with separately derived systems. The Ufer ground shall consist of the grounding electrode conductor itself, extended without splice into the bottom of the footing for at least 20 feet.
- C. Suspend conductor during concrete pour with tiwires such as used on rebar; maintain at least 2 inches of concrete cover. Bond conductor to rebar in at least one location.
- D. Structural steel columns in or adjacent to electrical rooms) (within 25 feet) with electrical service equipment or separately derived systems shall be connected to the adjacent Ufer ground with bare copper sized in accordance with NEC Table 250.66 to effectively ground

building steel. Connections shall be cadwelded to flange of structural steel column below top of slab (Bonding conductors shall be encased in slab).

### 3.10 SEPARATELY DERIVED SYSTEMS

- A. Separately derived systems shall be grounded in accordance with NEC Article 250.30.
1. Bonding jumper:
    - a. The bonding jumper shall be sized in accordance with NEC Table 250.66. Where the derived phase conductors are larger than 1100 kCMIL copper, the bonding jumper shall have an area that is not less than 12-1/2% percent of the area of the largest phase conductor.
    - b. The bonding jumper shall be used to connect the equipment Grounding conductors of the separately derived system to the grounded conductor.
    - c. The bonding jumper shall be located within the enclosure of the source of the separately derived system, unless specifically noted otherwise.
  2. Provide termination lugs for the co-located grounded conductor, grounding electrode conductor and bonding jumper terminations, using listed compression type connectors suitable for all conductors landed at each location.
  3. The grounded conductor of the separately derived system shall be bonded to the nearest available point of the interior metal water piping system in the area served by the separately derived system. The bonding jumper shall be sized in accordance with NEC Table 250.66.
  4. Grounding electrode:
    - a. The Grounding electrode shall be as near as practical to and preferably in the same area as the Grounding electrode conductor connection to the system.
    - b. The Grounding electrode conductor, sized in accordance with NEC Table 250.66, shall be used to connect the grounded conductor of the derived system to the Grounding electrode.
    - c. The Grounding electrode shall be the nearest two of the following:
      - 1). Effectively grounded structural metal member of the structure.
      - 2). Effectively grounded metal water pipe within 5 feet from the point of entrance into the building.
      - 3). Under ground.

**END OF SECTION 26 25 00**

**SECTION 26 26 10**  
**SURGE PROTECTIVE DEVICES (SPDS)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This specification describes requirements for the Surge Protective Devices (SPDs) devices for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching. The SPD devices shall be suitable for application in a Category C and B environment as described in ANSI/IEEE C62.41.2-2002.

**1.2 SCOPE**

- A. Provide labor, materials, equipment and services necessary for and incidental to the installation of the SPD System devices as specified herein. Installations shall be completed in accordance with this specification.
- B. Provide SPDs for Switchboards and Panelboards as indicated on the panelboard schedules or drawings.

**1.3 SPECIAL REQUIREMENTS**

- A. Where this specification or Specification Section 26 24 16 – Panelboards, specify a SPD device integral to a panelboard, the SPD shall be installed at the factory, delivered, and warranted by the electrical distribution equipment manufacturer.

**1.4 WARRANTY**

- A. The SPD shall have a warranty period of five years, incorporating unlimited replacements of module if destroyed by transients during the warranty period.

**1.5 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Provide submittal data with the following information:
  - 1. Product data and manufacturer's installation instructions.
  - 2. Dimensional drawing of each suppressor type indicating mounting arrangements.
  - 3. UL 1449, most recent edition, VPR test data for SPDs.
  - 4. UL 1283, most recent edition, Noise Attenuation for SPDs.
  - 5. UL Documentation verifying:
    - a. Short Circuit Current Rating (SCCR) of 200 kA.
    - b. I-Nominal rating of 20 kA.
    - c. Type 1 Device listing.
    - d. Maximum Continuous Operating Voltage (MCOV).

**1.6 CODES AND STANDARDS**

- A. U.L. compliance and labeling: Each complete suppression device shall be listed per U.L. 1449 (most recent edition) as a surge protective device.
- B. SPD shall be designed to allow installation in accordance with current National Electrical Code.
- C. ANSI/IEEE C62.41.2-2002, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits, Category B and C.
- D. NEC Article 285.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Acceptable manufacturers include: Advanced Protection Technologies, Current Technology, Liebert, Square D, or approved equal. The manufacturer shall be regularly engaged in the manufacture of SPDs and comply with ANSI/IEEE C62.41.1-2002 and ANSI/IEEE 62.41.2-2002 for at least five years. Specific products are subject to approval.
- B. Where SPDs are specified as an integral part of distribution equipment, the manufacturer of the SPD shall be partnered with the distribution equipment manufacturer in providing a UL listed device.

**2.2 SPDS GENERAL**

- A. SPD shall be compatible with the electrical system voltage, current, configuration and intended application.
- B. SPD shall be parallel in design.
- C. SPD shall be modular in design and MOV based. Each MOV shall be rated at 50kA each.
- D. SPD shall have a maximum continuous operation voltage (MCOV) not less than 115% of the nominal RMS voltage continuously without degradation.
- E. SPD shall provide both visual and audible indication of properly performing protection for each phase.
- F. The SPD shall have UL1283 EMI/RFI filtering with minimum attenuation of -50dB@100kHz.
- G. SPD shall provide full cycle tracking circuitry to provide tight transient clamping regardless of the transient position on the sine wave.
- H. SPD modules shall be thermally fused and SPD shall be capable of safely interrupting the power system's available fault current.
- I. SPD shall incorporate a low impedance surge diversion platform for the surge current path. The surge current shall be symmetrically disbursed to all suppression elements to insure equal stressing and maximum performance of the suppression elements. The surge diversion platform shall provide equal impedance paths to each suppression element for shunting of high frequency surges. The surge current diversion modules shall be bolted directly to the platform to insure reliable low impedance connections. Small gauge round wiring or plug-in connections shall not be used in the path for surge current diversion.

**2.3 BRANCH PANELBOARD SPD**

- A. SPD shall be tested against ANSI C62.41.2-2002 Category C High impulse and Category C low transients.
- B. SPD shall be capable of surviving 5000 sequential ANSI C62.41 B impulses, without failure or degradation of UL 1449 suppressed voltage rating by more than 10%.
- C. SPD shall have a maximum single impulse current rating of 100kA per phase.
- D. SPD shall provide protection in the following modes and SPD shall have a U.L. 1449 voltage protection rating (VPR) as follows:

Nominal Voltage	Configuration	L-N	N-G	L-G	L-L
120/208	Grounded Wye	700	700	700	1200
277/480	Grounded Wye	1200	1200	1200	2000

**2.4 SERVICE ENTRANCE SPDS**

- A. SPD shall be tested against ANSI C62.41.2-2002 Category C High impulse and Category C low impulse transients.
- B. SPD shall be capable of surviving 5,000 ANSI C62.41 C impulses, without failure or degradation of UL 1449 suppressed voltage rating by more than 10%.
- C. SPD shall have a maximum single impulse current rating of 200kA per phase.
- D. SPD shall provide protection in the following modes and SPD shall have a U.L. 1449 voltage protection rating (VPR) as follows:

Nominal Voltage	Configuration	L-N	N-G	L-G	L-L
277/480	Grounded Wye	1200	1200	1200	2000

**2.5 SPDS INTEGRAL TO DISTRIBUTION EQUIPMENT**

- A. SPD shall be Component Recognized in accordance with UL 1449, Standard for Safety, Surge Protective Devices.
- B. The SPD diagnostic monitoring devices shall be mounted on the front of the distribution equipment enclosure.
- C. SPD integral to service entrance switchboard shall include an internal UL Listed disconnect switch.

**PART 3 - EXECUTION**

**3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

**3.2 INSTALLATION**

- A. Provide SPDs integral to panelboards as indicated on the panel schedules or drawings and in accordance with Specification Section 26 29 13 – Distribution Switchboards and Specification Section 26 24 16 - Panelboards. Where SPDs are specified as an integral part of the distribution equipment, they shall be installed as follows:
  - 1. SPD shall be installed by and shipped from the electrical equipment manufacturer's factory.

**END OF SECTION 26 26 10**

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**SECTION 26 26 20**  
**OVERCURRENT PROTECTIVE DEVICES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. Thermal Magnetic Molded Case Circuit Breakers.
  - 2. Electronic Trip Molded Case Circuit Breakers.
  - 3. Fusible switches and fuses.
- B. Scope: Provide Overcurrent Protective Devices as specified herein and as shown on schedules and/or drawings.
- C. Related Requirements:
  - 1. Section 26 29 13 – Distribution Switchboards.
  - 2. Section 26 24 16 – Panelboards.
  - 3. Section 26 26 10 – Surge Protective Devices.

**1.2 REFERENCES**

- A. The circuit breaker(s) referenced herein shall be designed and manufactured according to the latest revision of the following standards.
  - 1. ANSI/NFPA 70 - National Electrical Code (NEC).
  - 2. NEMA AB 1 - (National Electrical Manufacturers Association) Molded Case Circuit Breakers and Molded Case Switches.
  - 3. UL 489 - (Underwriters Laboratories Inc.) Molded Case Circuit Breakers and Circuit Breaker Enclosures.
  - 4. UL 943 - Standard for Ground Fault Circuit Interrupters.
  - 5. UL 1053 – Ground Fault Sensing and Relaying Equipment.
  - 6. CSA C22.2 No. 5 - (Canadian Standard Association) Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures.
  - 7. Federal Specification W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
  - 8. Federal Specification W-C-865 - Fusible Switches.
  - 9. IEC 60947 – Low Voltage Switchgear and Control Gear – Part 2: Circuit Breakers.
  - 10. IEC 61000-4 Series – Electromagnetic Compatibility.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Submit product data for each type of overcurrent protective device, ground fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and Finishes.
- C. Provide outline drawings with dimensions, and ratings for voltage, amperage and maximum interruption. Include instructions for circuit breaker mounting, trip unit functions and adjustments, trouble shooting, accessories and wiring diagrams.
- D. Provide a complete protective device coordination study for the entire electrical distribution system. Provide specific recommendations for circuit breaker settings (trip, time delays, etc.), relays and ground fault devices. The study shall be performed by a Registered Professional Engineer who has at least five (5) years experience in performing system studies. Submit qualifications with study.

- E. Coordination data to check protective devices: Manufacturer shall provide electronic and hard copy time/current characteristic trip curves (and  $I_p$  &  $I^2t$  let through curves for current limiting circuit breakers) for each type of circuit breaker.
- F. Provide information required to verify compliance with the short circuit withstand and interrupting ratings, as shown on the Drawings or further stated in these Specifications.

#### 1.4 QUALITY CONTROL

- A. Devices shall be the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with applicable standards and UL listings.
- B. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors installed in the State of Alaska must be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.
- C. The overcurrent protection device manufacturing facility shall be Registered by Underwriters Laboratories Inc. to the International Organization for Standardization ISO 9000 Series Standards for quality.

### PART 2 - PRODUCTS

#### 2.1 BASIS OF DESIGN

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from Cutler-Hammer, Seimens Energy & Automation, General Electric, or alternative systems will be considered providing that sufficient documentation is provided to the Contracting Agency that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points that are pertinent to the Project.

#### 2.2 MOLDED CASE CIRCUIT BREAKERS

- A. General Characteristics:
  - 1. Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle, and the accessory mounting area.
  - 2. Circuit breakers shall have an over center, trip free, toggle operating mechanism which shall provide quick make, quick break contact action. The circuit breaker shall have common tripping of all poles.
  - 3. The circuit breaker handle shall reside in a tripped position between on and off to provide local trip indication. Circuit breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings.
  - 4. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
  - 5. Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.
  - 6. Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end use equipment along with the statement "Caution - Series Rated System. \_\_\_\_\_ A Available. Identical Replacement Component Required".
  - 7. MCCBs shall be able to receive a device for locking in the isolated position.
  - 8. Electronic components shall withstand temperatures up to 221°F (105°C).

9. Circuit breakers shall be UL listed to accept field installable/removable mechanical type lugs (except Type QB/QD/QG/QJ).
  10. Lugs shall be UL listed to accept solid (not larger than #8 AWG) and/or stranded copper and aluminum conductors. Lugs shall be suitable for 75°C rated wire or 90 C rated wire, sized according to the 167°F (75°C) temperature rating in the NEC.
- B. Trip Unit:
1. General:
    - a. MCCBs with ratings up to 400 amperes shall be equipped with thermal magnetic trip units.
    - b. MCCBs with ratings over 400 amperes shall be equipped with electronic trip units.
    - c. Circuit breakers with permanent trip units shall be UL listed for reverse connection without restrictive line and load markings and shall be suitable for mounting in any position.
    - d. The trip units shall not augment overall circuit breaker volume.
  2. Thermal Magnetic (400 Ampere Frame and Below):
    - a. Basis of Design: PowerPact Q, H and J Frame, FA, LA, and LH as manufactured by Square D by Schneider Electric.
    - b. General:
      - 1). Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 F (40 C) ambient temperature. Circuit breaker frame sizes above 150 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker
  3. Electronic Trip Circuit Breakers:
    - a. MICROLOGIC Trip System:
      - 1). Basis of Design: PowerPact L, P and R Frame (>400 - 3000 amperes) as manufactured by Square D by Schneider Electric.
      - 2). General:
        - a) Circuit breaker trip system shall be a MICROLOGIC electronic trip unit with true RMS sensing.
        - b) Current transformers shall be used to ensure accurate measurements from low current up to high currents.
        - c) Electronic trip unit shall be fitted with thermal imaging.
        - d) The following monitoring functions shall be integral parts of electronic trip units:
          - i. A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.
          - ii. LED for load indication at 105 percent.
          - iii. LED for load indication at 90 percent of load for applications 600A and smaller.
          - iv. LED for visual verification of protection circuit functionality for applications 600A or smaller.
          - v. LED for trip indication for applications above 600A.
      - e) MICROLOGIC trip unit functions shall consist of adjustable protection settings with the capability to be set and read locally by rotating a switch.
        - i. Long time pickup shall allow for adjustment to nine long time pickup settings. This adjustment shall be at least from 0.4 to 1 times the sensor plug (I<sub>n</sub>), with finer adjustments available for more precise settings to match the application.
        - ii. Adjustable long-time delay shall be in nine bands. At six times I<sub>r</sub>, from 0.5 to 24 seconds above 600A, and 0.5 to 16 seconds for 600A and below.
        - iii. Short time pickup shall allow for nine settings from 1.5 to 10 times I<sub>r</sub>.

- iv. Short time delay shall be in nine bands from 0.1–0.4 I<sub>2 t</sub> ON and 0 - 0.4 I<sub>2 t</sub> OFF.
  - v. Instantaneous settings on the trip units with LSI protection shall be available in nine bands.
    - Above 600A, from 2 to 15 times I<sub>n</sub>
    - 600A, from 1.5 to 11 times I<sub>n</sub>
    - 400A from 1.5 to 12 times I<sub>n</sub>
    - 250A and below, from 1.5 to 15 times I<sub>n</sub>
  - vi. Ground fault settings for circuit breaker sensor sizes 1200 amperes or below shall be in nine bands from 0.2 to 1.0 times I<sub>n</sub>. The ground fault settings for circuit breakers above 1200 amperes shall be nine bands from 500 amperes to 1200 amperes.
  - f) It shall be possible to fit the trip unit with a seal to prevent unauthorized access to the settings in accordance with NEC Section 240-6(b).
  - g) Trip unit shall provide local trip indication and capability to locally and remotely indicate reason for trip, i.e., overload, short circuit, or ground fault.
  - h) Provide neutral current transformers for four wire systems.
  - i) Trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments shall be 1 ampere. Fine increments for delay adjustments shall be one second.
  - j) Trip units shall be available to provide real time metering. Metering functions shall include, but shall not be limited to, the following:
    - i. Current (phases, neutral, average, maximum).
    - ii. Voltage (phase to phase, phase to neutral, average, unbalance).
    - iii. Power (active [kW], reactive [kVAR], apparent [kVA], power factor).
    - iv. Energy (active [kWh], reactive [kVAR], apparent [kVA]).
    - v. Frequency.
    - vi. Metering accuracy shall be 1.5 percent current (above 600A), 1.0 percent current (600A and below), 0.5 percent voltage, and 2 percent energy. Accuracies shall be total system, including, but not limited to, CT and meter.
  - k) Measurement chain shall be independent from the protection chain.
  - l) The measurements shall be displayed on the breaker itself and/or on a remote display and/or on a remote system via Modbus communication.
  - m) Connections from circuit breaker to remote display and/or communication module shall be plug-n-play via RJ45 connector. No special tools or programming shall be required.
- C. Accessories:
- 1. General:
    - a. Circuit breakers shall be equipped with UL listed electrical accessories as noted on the Drawings or schedules or they may be field installable.
    - b. The addition of auxiliaries shall not increase the volume of the circuit breaker.
  - 2. Handle Accessories:
    - a. Circuit breaker handle accessories shall provide provisions for locking handle in the on and off position.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings. Install circuit

- B. Size devices as shown and specified, or as required by the load being served.

**3.2 ADJUSTMENTS**

- A. Circuit breaker pick-up level and time delay settings shall be adjusted to values indicated by the required coordination study unless otherwise instructed by the Contracting Agency.

**END OF SECTION 26 26 20**

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**SECTION 26 26 30  
MOTOR STARTERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general requirements, products, and methods of execution relating to manual and magnetic Motor Starters provided in this and other Divisions. Overloads shall be furnished and installed in Divisions 26, 27 and 28.

**1.2 QUALITY CONTROL**

- A. Equipment shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with the governing standards.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.

**PART 2 - PRODUCTS**

**2.1 BASIS OF DESIGN**

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

**2.2 AC FRACTIONAL MANUAL STARTERS**

- A. The manual starter shall consist of a manually operated toggle switch equipped with red pilot light and melting alloy type thermal overload relay.
- B. Thermal unit shall be one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.

**2.3 AC MANUAL STARTERS--LINE VOLTAGE TYPE**

- A. Manual starters shall be constructed and tested in accordance with the latest published NEMA standards.
- B. The manual starters shall consist of a manually operated switch equipped with red pilot light and melting alloy type thermal overload relays in every phase conductor. Thermal units shall be one piece construction and the starter shall be inoperative if any thermal unit is removed.
- C. Starters shall be furnished in a NEMA 1 general purpose enclosure unless otherwise indicated on the plans or required by the conditions of the area in which they are installed.

**2.4 AC MAGNETIC STARTERS--LINE VOLTAGE TYPE**

- A. Motor starters shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes and horsepower ratings.
- B. Starters shall be mounted in NEMA 1 general purpose enclosures unless otherwise indicated on plans or required by the conditions of the area in which they are installed.
- C. Starters shall be furnished with overload relays in every phase conductor and starters shall be inoperative if any overload unit is removed.

1. Overload relays shall be the solid state type. Trip current rating shall be established by selection of overload relay and shall be adjustable (3 to 1 current range). The overload shall be self-powered, provide phase loss and phase unbalance protection, have a permanent tamper guard, and be ambient insensitive. Overload shall be standard trip (Class 20) and shall have a mechanical test function.
- D. Starters through NEMA size five (5) shall be equipped with double break silver alloy contacts. Contacts shall be replaceable without removing power wiring or removing starter from panel.
- E. Coils shall be of molded construction and shall be 120 VAC. Starters shall have a fused 120V control power transformer in enclosure, or alternatively on 120/208 volt systems, the power system neutral conductor may be utilized. In all cases, control power shall be disconnected by the starter disconnecting means, unless otherwise specifically approved.
- F. Starters shall be suitable for field addition of at least four (4) auxiliary electrical interlocks of any arrangement, normally-open or normally-closed.
- G. Starters shall have enclosure mounted red running pilot light and Hand-Off-Auto switch.

## **2.5 AC COMBINATION STARTERS WITH FUSIBLE DISCONNECT SWITCH OR CIRCUIT BREAKER**

- A. Combination starters shall be manufactured in accordance with the latest published NEMA standards, sizes and horsepower ratings.
- B. Disconnect switch combination starters shall consist of a visible blade disconnect switch and a motor starter.
- C. Combination starters shall be mounted in NEMA 1 general purpose enclosures unless otherwise indicated on the plans or required by the conditions of the area in which they are installed.
- D. The disconnect handle used on combination starters shall always be in control of the disconnect device with the door opened or closed. The disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".
- E. Magnetic starters provided under all Divisions of the Specifications shall be in accordance with this Section.

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 COORDINATION**

- A. Coordinate all details pertaining to the motor control equipment with the Division of these specifications where the equipment is specified.

### **3.3 CONTROL WIRING**

- A. Control wiring and control devices shall be provided under the Specification Division in which the controlled equipment is specified. Coordinate all related work.

### **3.4 CONNECTIONS**

- A. Provide liquid-tight flexible conduit connections to motors and other equipment subject to vibration where LFMC is an acceptable wiring method. Provide flexible conduit connections to motors and other equipment subject to vibration that is located in spaces used for environmental air (e.g. fan rooms). Minimum length 12 inches.

**3.5 NAMEPLATES**

- A. Provide engraved nameplates for starters. Coordinate names with mechanical equipment lists.

**3.6 REDUCED VOLTAGE STARTERS**

- A. Reduced voltage starters shall be provided for all motors larger than:

208 volts	25 horsepower
460 volts	50 horsepower

1. This requirement shall apply to starters furnished in this Division and other Divisions of the specifications.
2. Motors controlled by Variable Frequency Drives (VFDs) are not subject to this requirement.

**3.7 TWO SPEED STARTERS**

- A. Provide two speed starters for all two speed motors. Starters shall comply with the requirements of the equipment and motor manufacturers. Refer to Mechanical Equipment Lists for equipment with two speed motors.
- B. This requirement shall apply to starters furnished in this Division and other Divisions of the specifications.

**END OF SECTION 26 26 30**

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**SECTION 26 26 40  
CONTACTORS**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Lighting Contactors.

**1.2 REFERENCES**

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- C. ANSI/NFPA 70 - National Electrical Code.

**1.3 QUALITY CONTROL**

- A. Contactors shall be of the latest approved design as manufactured by a nationally recognized manufacturer and be Underwriters' Laboratory listed and bear the UL label.
- B. Contactors of each type provided shall include the features as indicated on the Drawings.

**1.4 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Submit for approval manufacturer's shop drawings to show dimensions, features, accessories, enclosures, mounting arrangements, interconnecting diagrams, schedules of overcurrent devices, voltage ratings, and specified accessories.

**1.5 PROJECT RECORD DOCUMENTS**

- A. Submit under provisions of Division 1.
- B. Accurately record actual locations of each contactor and indicate circuits controlled.

**1.6 OPERATION AND MAINTENANCE DATA**

- A. Submit under provisions of Division 1.
- B. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

**PART 2 - PRODUCTS**

**2.1 BASIS OF DESIGN**

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from other manufacturers will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

**2.2 CONTACTOR FEATURES - GENERAL**

- A. Enclosures:
  - 1. Enclosures shall be ANSI/NEMA ICS 6, Type 1, 3R, 4 or 12 as indicated on the drawings or as required to meet conditions of the installation.
- B. Accessories:
  - 1. Provide the following accessories as indicated for each contactor:
    - a. Pushbutton: ON/OFF. NEMA ICS 2, heavy duty type.

- b. Selector Switches: HAND/OFF/AUTOMATIC. NEMA ICS 2, heavy duty type.
  - c. Auxiliary Contacts: field convertible, quantity indicated.
  - d. Pilot Lights: Red – On. Provide require interlock.
  - e. Other: as indicated.
- C. Coil Voltages: 120 or 277 volts, 60 Hz, as indicated for each contactor.
  - D. Poles: As indicated or required for the specific application.
  - E. Contact Rating: as indicated or as required to meet conditions of the installation.
  - F. Size: As indicated or required by the load.
  - G. Configuration: Provide types as indicated:
    - 1. Electrically held shall have continuously rated, encapsulated coils.
    - 2. Mechanically held shall be electrically operated with encapsulated coils. Standard coil clearing contacts are to be provided so that the contactor coils shall be energized only during the instance of operation.

### **2.3 MULTIPOLE LIGHTING CONTACTORS**

- A. Square D Company - 8903 Type L & LX.
- B. Description: magnetic lighting contactor.
- C. Contact Rating: 20 amperes for all types of ballast and tungsten lighting, resistive heating, and motor loads.
- D. Contacts: Totally enclosed, double-break silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring. All contacts shall have clearly visible N.O. and N.C. contact status indicators.
- E. Wiring: Straight-through wiring with all terminals clearly marked.

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.

### **3.3 SCHEDULE**

- A. Refer to the Drawings for Contactor requirements.

### **3.4 NAMEPLATES**

- A. Provide engraved nameplates for all Contactors in accordance with Section 26 00 00 - Electrical General Provisions.

**END OF SECTION 26 26 40**

**SECTION 26 27 26  
WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general provisions, products and methods of execution relating to line voltage Wiring Devices for use on this project.

**1.2 QUALITY CONTROL**

- A. Manufacturers mentioned and catalog numbers specified are for establishment of type, configuration and quality. Other manufacturers and types may be submitted for approval.

**1.3 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Do not place order for devices, plates, etc., without ensuring that the Contracting Agency has positively approved Submittals for the specific colors necessary for all applications and locations. Note that the selection of one color for general use does not rule out the selection of other colors for special applications or for aesthetic reasons.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Catalog numbers shown are Hubbell unless noted otherwise. Equal devices manufactured by Arrow Hart (by Cooper Wiring Devices) and Bryant are acceptable. Provide all similar devices of same manufacturer.

**2.2 SWITCHES**

- A. Provide 20 AMP, 277V rated switches with UL listing for tungsten lamp loads or inductive loads without derating. Switches shall be as follows:

	20A
Single Pole	CAT. NO. 1221
Three-way	CAT. NO. 1223
Four-way	CAT. NO. 1224
Key Operated	CAT. NO. 1221-L
Momentary Cont.	CAT. NO. 1557
Double Pole	CAT. NO. 1222
Pilot Switch	CAT. NO. 1221-PL

- B. Multiple 277V switches shall be installed in partition boxes or shall be furnished with shields.
- C. Other switch types shall be provided as called for on the Drawings or as required by the application.

**2.3 RECEPTACLES**

- A. Provide grounding type receptacles as follows, or as required to match equipment furnished in this or other divisions.

Single Phase, 3-Wire Devices		
20A-125V	CAT. NO. 5362	NEMA #5-20R
20A-125V GFCI	CAT. NO. GF-5362	NEMA #5-20R
20A-125V Tamper Proof	CAT NO. HBL8300SG	NEMA #5-20R
20A-250V	CAT. NO. 5462	NEMA #6-20R
30A-250V Dryer	CAT. NO. RR430F	NEMA #14-30R
50A-250V Range	CAT. NO. RR450F	NEMA #14-50R

- B. Outlets requiring ratings and configurations different from those listed above shall be provided as shown on the plans and/or required by the equipment served.

## 2.4 LOW VOLTAGE LIGHTING CONTROL SWITCHES

- A. Refer to Section 26 2749 - Network Lighting Control System.

## 2.5 FLUORESCENT DIMMERS

- A. Refer to Section 26 2749 - Network Lighting Control System.

## 2.6 OCCUPANCY SENSORS

- A. Refer to Section 26 2749 - Network Lighting Control System.

## 2.7 DEVICE COLOR

- A. Device color shall be as selected by the Department, unless otherwise noted.

## 2.8 DEVICE PLATES

- A. Device plates shall be satin-finished 302 stainless steel, unless otherwise noted.
- B. Indoor device plates for surface-mounted boxes shall be stainless or galvanized steel, with design to match the box and device type being used.
- C. Weatherproof outlet plates shall be of the safety outlet enclosure type that can be closed to remain weatherproof while in use. The outlet cover/enclosure shall be clearly marked "Suitable for Wet Locations While In Use" and "UL Listed". A gasket shall be provided between the enclosure and the mounting surface, and between the hinged cover and the mounting plate/base to assure a proper seal. Enclosure shall be oversized depth, single-gang, vertical-mount, with non-locking latch, GFCI opening, cord openings, and cover; TayMac; Specification Grade or approved equal.
- D. Engrave branch circuit designation (panel and circuit number) on receptacle and light switch device plates, e.g., "PA-30"). Verify final panel designations with Contracting Agency prior to engraving nameplates.

## 2.9 PHOTOCELLS

- A. Outdoor Photocells
1. Basis of design is Intermatic K4236C Stem and Swivel Mounting Photocell.
  2. Photocell shall have minimum of 2400 V open type spark gap arrestor to protect against voltage surges.
  3. Photocell shall be weatherproof or be provided with weatherproof case.

### **PART 3 - EXECUTION**

#### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

#### **3.2 INSTALLATION**

- A. Install Wiring Devices indicated complete with cover plates. Cover plates shall fit snugly against finished surfaces and line up true with adjacent building lines, and be symmetrical in location and appearance.
- B. Switches shall be installed so their handles move in a vertical plane.
- C. Door swings shall be checked and, if necessary, switches shall be relocated to place them on the strike side of the door.
- D. Unless otherwise noted on the drawings, receptacles shall be installed in the vertical position with the grounding pin down unless wording on the face of the device requires other mounting.
- E. All NEMA 5 configuration receptacles located in shops whether on single or multiple receptacle circuits shall be rated at least 20 amps.

**END OF SECTION 26 27 26**

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**SECTION 26 27 49**  
**NETWORK LIGHTING CONTROL SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This section includes a complete networked lighting control system for the control of lighting as indicated on the plans and further defined in the Specifications.
- B. The system includes but is not limited to the following subsystems and components: :
  - 1. Lighting management panel
  - 2. Quantum manager – light management computer
  - 3. Q-Admin – light management computer software
  - 4. Personna PC – web-based personal control software
  - 5. Factory assembled dimming and switching panels
  - 6. Low voltage wall control stations
  - 7. Control interfaces
  - 8. Modular dimming control with scene selection
  - 9. Digital fluorescent dimming ballasts
  - 10. Occupancy sensors
  - 11. EcoSystem components and ballast module interfaces (addressable fixture lighting control)
  - 12. Permanently installed occupancy/vacancy sensors (power packs as needed)

**1.2 RELATED SECTIONS:**

- 1. Section 25 50 00 - Building Automation and Control
- 2. Section 25 90 00 - Sequence of Operation
- 3. Section 26 27 26 - Wiring Devices
- 4. Section 26 50 00 - Lighting Fixtures
- 5. Section 26 50 10 - Lamps, Ballasts and Accessories

**1.3 REFERENCES**

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
  - 1. C62.41 - Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- B. International Organization for Standardization (ISO)
  - 1. 9001:2000 - Quality Management Systems.
- C. National Electrical Manufacturers Association (NEMA)
- D. Underwriters Laboratories, Inc. (UL)
  - 1. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  - 2. 508 - Standard for Industrial Control Equipment.
  - 3. 1472 - Solid-State Dimming Controls.
  - 4. 924 - Emergency Lighting and Power Equipment
  - 5. 935 – Fluorescent Ballasts
  - 6. 1472 – Solid-State Dimming Controls
- E. Federal Communications Commission (FCC) rules - Part 15 (Class B): Radio Frequency Devices

#### 1.4 SUBMITTALS

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.
- C. Provide shop drawings including:
  - 1. Complete building lighting control diagram including all panels and major components of system.
  - 2. Complete interconnection diagrams of fixtures, devices and equipment. Diagrams shall include wiring type(s) and designation whether cabling is installed in conduit or other method.
  - 3. Locations of fixtures, devices and equipment on a room by room basis. Similar rooms may be combined as a "Typical" layout.
  - 4. Load schedule indicating load description, load type, voltage, emergency or normal, circuit numbers and their respective control zones.
  - 5. Sequence of operation. Describe how each area operates and how building wide functionality is employed.

#### 1.5 QUALITY CONTROL

- A. Manufacturer: Minimum 5 years experience in manufacture of architectural lighting controls.
- B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.
- C. Lighting control system components shall be UL listed.

#### 1.6 PROJECT CONDITIONS

- A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
  - 1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).
  - 2. Relative humidity: Maximum 90 percent, non-condensing.
  - 3. Lighting control system shall be protected from dust during installation.

#### 1.7 WARRANTY

- A. Provide manufacturer's Enhanced 8 Year Silver Level Limited Parts Warranty:
  - 1. Years 1-2:
    - a. 100 percent replacement parts for manufacturer lighting system components
    - b. 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue
    - c. First-available onsite or remote response time
  - 2. Years 3-5: 50 percent replacement parts coverage
  - 3. Years 6-8: 25 percent parts coverage
  - 4. 24 hours per day, 7 days per week telephone technical support (excluding manufacturer holidays)
- B. Provide 1-year parts and labor warranty for Quantum Manager.
- C. Provide 1-year warranty for Quantum Software.
- D. Provide manufacturer's warranty covering 5 years with factory startup on ballasts, ballast modules, and drivers.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design is equipment: Lutron Quantum facility management solution to set a standard for quality. Equipment from alternate manufacturers (Acuity Brands, Philips Dynalite, ETC) are acceptable provided that they meet the requirements of the specification.
- B. Alternate equipment/methodology of lighting control shall be submitted as a Substitution.

### **2.2 GENERAL**

- A. Provide system hardware that is designed, tested, manufactured, and warranted by a single manufacturer.
- B. Architectural Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.
- C. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
- D. Wireless Devices shall:
  - 1. Have addresses automatically assigned to them.
  - 2. Receive signals from other wireless devices and provide feedback to user.
  - 3. Work in conjunction with wireless occupancy sensors, wireless vacancy sensors, and wireless controllers.
  - 4. Use proprietary Radio Frequency (RF) protocol.
  - 5. Use RF communication in compliance with FCC Part 15.231.

### **2.3 DIMMING / RELAY PERFORMANCE REQUIREMENTS**

- A. Electrolytic capacitors to operate at least 20 degrees C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40 degrees C (104 degrees F) ambient temperature.
- B. Load Handling Thyristors (SCRs and triacs), Field Effect Transistors (FETs), and Isolated Gate Bipolar Transistors (IGBTs): The component's maximum current rating to be at least two times the dimmer's/relay's rated operating current.
- C. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.
- D. Design and test dimmers to withstand line-side surges without impairment to performance.
  - 1. Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41.
  - 2. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.
- E. Utilize air gap off - activated when user selects "off" at any control to disconnect the load from line supply.
- F. Power failure memory and dimmer/relay recovery:
  - 1. When power is interrupted and subsequently returned, within 3 seconds lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption.
- G. Dimmers
  - 1. Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage/cycle), frequency shifts (plus or minus 2 Hz change in frequency/second), dynamic harmonics, and line noise.

2. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.
  3. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
    - a. Fluorescent electronic dimming ballast: Refer to Section 16501 - Lamps, Ballasts and Accessories.
  4. Utilize air gap off to disconnect the load from line supply.
  5. Control light sources in smooth and continuous manor.
  6. Each dimmer shall be assigned a load type that will provide proper dimming curve for the specific light source.
  7. Possess ability to have load types assigned per circuit, configured in field.
  8. Minimum and maximum light levels user adjustable on circuit-by-circuit basis.
  9. Line voltage dimmers shall meet the following load specific requirements:
    - a. Magnetic Low Voltage (MLV) transformer:
      - 1). Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
      - 2). Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
    - b. Electronic Low Voltage (ELV) transformer: Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.
  10. Low Voltage Dimming Modules shall meet the following requirements:
    - a. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
    - b. Single low voltage dimming module; capable of controlling following light sources:
      - 1). 0-10V analog voltage signal.
        - a) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
        - b) Sink current via IEC 60929.
        - c) Source current.
      - 2). 10-0V reverse analog voltage signal.
      - 3). DSI digital communication.
      - 4). DALI broadcast communication IEC 60929:
        - a) Logarithmic intensity values in compliance with IEC 60929.
        - b) Linear intensity values for use with LED color intensity control.
      - 5). PWM IEC 60929.
- H. Non-dim circuits shall meet the following requirements
1. Rated life of relay at full load: Minimum 1,000,000 cycles.
  2. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
  3. Fully rated output continuous duty for inductive, capacitive, and resistive loads.

## 2.4 POWER PANELS – LUTRON XP SERIES

- A. Mechanical
1. Listed to UL 508 as industrial control equipment.
  2. Delivered and installed as a UL listed factory assembled panel.
  3. Field wiring accessible from front of panel without need to remove dimmer assemblies or other components.
  4. Panels passively cooled via free-convection, unaided by fans or other means.

5. Ship panels with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

B. Electrical

1. Panels contain branch circuit protection for each input circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.
2. Branch circuit breakers; meet following performance requirements:
  - a. Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
  - b. Contain visual trip indicator; rated at 18,000 AIC, 277 V Switching.
  - c. Thermal-magnetic construction for overload, short-circuit, and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
  - d. Accept tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.
  - e. Replaceable without moving or replacing dimmer/relay assemblies or other components in panel. UL listed as switch duty (SWD) so that loads can be switched on and off by breakers.
3. Minimum UL listed Short Circuit Current Rating (SCCR) of 25,000A.
4. Utilize air gap off to disconnect the load from line supply.

**2.5 LUTRON XP SOFTSWITCH SERIES SWITCHING PANEL**

- A. Flush mounted.
- B. Rated life of relay: Minimum 1,000,000 cycles.
- C. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
- D. Fully rated output continuous duty for inductive, capacitive, and resistive loads.

**2.6 LUTRON CIRCUIT SELECTOR [PANEL PROCESSOR]:**

- A. Provide the following capabilities:
  1. Operate circuits directly from panel processor for system diagnostics and provide feedback of system operation.
  2. Electronically assign each circuit to any zone in lighting control system.
  3. Determine normal/emergency function of panel and set emergency lighting levels.
- B. Where indicated on Drawings, panels to provide two control links. Each circuit to be capable of transferring control based on independent programming between architectural control system and theatrical controls utilizing the USITT DMX-512 1990 or ESTA DMX-512A protocol.
- C. React to changes from control within 20 milliseconds.

**2.7 DIAGNOSTICS AND SERVICE**

- A. Replacing dimmer/relay does not require re-programming of system or processor.
- B. Dimmers/relays: Include diagnostic LEDs to verify proper operation and assist in system troubleshooting.
- C. Dimming/relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
  1. If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.

2. If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.
3. If dimmer fails, factory-installed mechanical bypass jumpers to allow each dimmer to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

## 2.8 FLUORESCENT ELECTRONIC DIMMING BALLASTS

### A. General

1. Ten-year operational life while operating with a case temperature range of 10 degrees C (50 degrees F) to 75 degrees C (167 degrees F) and 90 percent non-condensing relative humidity.
2. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.
3. Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the ballast is under fully-loaded conditions and case temperature is 75 degrees C (167 degrees F).
4. Programmed Rapid Start Type.
5. Maximum inrush current of 7 amperes for 120V ballasts and 3 amperes for 277V ballasts.
6. Current crest factor (CCF) less than 1.7.
7. Meet ANSI C82.11 High frequency ballast standard.
8. Will not interfere with infrared devices operating at frequencies between 38 kHz and 42 kHz.
9. Withstand up to a 6,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
10. Manufactured in a facility that employ ESD reduction practices in compliance with ANSI/ESD S20.20.
11. Inaudible in a 27 dBA ambient.
12. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
13. Total Harmonic Distortion less than 10 percent and meet ANSI C82.11 maximum allowable THD requirements
14. Actively prevent overheating in T5-HO linear fluorescent lamp applications.
15. Ballasts to track evenly across multiple lamp lengths and all light levels.

### B. Digital Control: Lutron ecosystem H-series

1. Continuous dimming from 100 percent to 0.7 percent relative light output, at 1.17BF for T8 U-bend and linear fluorescent lamps. 1.0 percent relative light output, at 1.0 BF for T5 and T5-HO lamps.
2. Monitor and report lamp and ballast status.
3. Lights automatically return to the setting prior to power interruption.
4. Each ballast responds independently to:
  - a. Up to 32 occupant sensors.
  - b. Up to 64 personal control inputs.
  - c. Up to 2 daylight sensors
5. Unique internal reference number visibly displayed on ballast cover.
6. Averages 2 independent daylight harvesting inputs internally.
7. Responds to digital load shed command.
  - a. Sets high end trim.
  - b. Automatically scales light output proportional to load shed command.
    - 1). Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by 3 percent to 27 percent.

8. Generate digital communication commands to distribute ballast data on the digital bus.

## **2.9 POWER MODULES [GRAFIK EYE QS]**

- A. Preset lighting control with zone override:
  1. The information screen on the GRAFIK Intensity for each zone indicated by means of one illuminated bar graph per zone.
  2. User-programmable zone and scene names.
  3. Utilize air gap off to disconnect the load from line supply.
  4. Astronomical time clock and programmer interface
    - a. Provide access to:
      - 1). Scene selections.
      - 2). Fade zone to a level.
      - 3). Fine-tuning of preset levels with scene raise/lower.
      - 4). Lock out scenes and zones.
      - 5). Fine-tuning of light levels with individual zone raise/lower.
      - 6). Terminal block for wired infrared signal input.
      - 7). Enable/disable wall station.
  5. Light intensity with real time energy savings by digital display.
  6. Fade time indicated by digital display for current scene while fading.
  7. Integral wide angle infrared receiver.
  8. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.
- B. Preset shade control with zone override:
  1. Preset expandable shade control: Provide up to 3 columns of shade control.
  2. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.

## **2.10 [ENERGI SAVR NODE] LIGHTING CONTROL MODULE**

- A. Softswitch switching lighting control module. QSN-4S16-S
  1. Mechanical: Listed to UL 508 as industrial control equipment.
  2. Delivered and installed as a UL listed factory assembled panel.
  3. Panels passively cooled via free-convection, unaided by fans or other means.
  4. Surface mounted.
  5. Switching
    - a. Rated life of relay: Minimum 1,000,000 cycles.
    - b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
    - c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
    - d. Module to integrate up to 4 individually controlled zones, each with a capacity of up to 16 amps, of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).
    - e. Utilize air gap off – activated when user selects “off” at any control to disconnect the load from line supply.
  6. Connection to the following without an interface device:
    - a. Occupancy sensors
    - b. Daylight sensors
    - c. IR receivers for personal control
  7. Capable of being controlled via wireless sensors and controls
  8. Connects to lighting management panel via RS485.
  9. LED status indicators confirm communication with occupancy sensors, daylight sensors and IR receivers.

10. Contact closure input: Directly accept contact closure input from a dry contact closure or solid-state output without interface to accomplish the following:
    - a. Activate scenes (momentary or maintained closure)
    - b. Enable or disable afterhours
      - 1). Automatic sweep to user-specified level after user-specified time has elapsed
      - 2). System will provide occupants a visual warning prior to sweeping lights to user-specified level
      - 3). Occupant can reset timeout by pressing a button on a control station
    - c. Activate or deactivate demand response (load shed). Load shed event will reduce lighting load by user-specified amount.
  11. Emergency Contact Closure Input
    - a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
    - b. Allow configurable zone response during emergency state.
    - c. Disable control operation until emergency signal is cleared.
- B. 0-10V Lighting Control Module:
1. Product: QSN-4T16-S
  2. Meet the following requirements:
    - a. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
    - b. Single low voltage dimming module; capable of controlling following light sources:
      - 1). 0-10V analog voltage signal.
        - a) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
        - b) Sink current per IEC 60929.
      - 2). 10V – 0V analog voltage signal
        - a) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
        - b) Sink current per IEC 60929.
  3. Mechanical:
    - a. Listed to UL 508 (United States) as industrial control equipment. CSA (Canada) certified, or NOM (Mexico) approved as applicable.
    - b. Delivered and installed as a [UL] [CSA] listed factory assembled panel.
    - c. Panels passively cooled via free-convection, unaided by fans or other means.
  4. Surface mounted
  5. Switching:
    - a. Rated life of relay: Minimum 1,000,000 cycles.
    - b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
    - c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
    - d. Module to integrate up to 4 individually controlled zones, each with a capacity of up to 16 amps, of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, HID, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads).
    - e. Utilize air gap off – activated when user selects “off” at any control to disconnect the load from line supply.
  6. Connection without interface to wired:
    - a. Occupancy sensors
    - b. Daylight sensors
    - c. IR receivers for personal control
  7. Capable of being controlled via wireless sensors and controls
  8. Connects to Lighting Management Panel via RS485.

9. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
  10. Contact Closure Input
    - a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:
      - 1). Activate scenes
        - a) Scene activation from momentary or maintained closure
      - 2). Enable or disable afterhours
        - a) Automatic sweep to user-specified level after user-specified time has elapsed
        - b) System will provide occupants a visual warning prior to sweeping lights to user-specified level
        - c) Occupant can reset timeout by interacting with the lighting system
      - 3). Activate or deactivate demand response (load shed)
        - a) Load shed event will reduce lighting load by user-specified amount
  11. Emergency Contact Closure Input
    - a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
    - b. Allow configurable zone response during emergency state.
    - c. Disable control operation until emergency signal is cleared.
- C. [EcoSystem] Digital Fixture Lighting Control Module
1. Product: [QSN-1ECO-S], [QSN-2ECO-S]
  2. Mechanical:
    - a. Listed to UL 508 (United States) as industrial control equipment. CSA (Canada) certified, or NOM (Mexico) approved as applicable.
    - b. Delivered and installed as a [UL] [CSA] listed factory assembled panel.
    - c. Panels passively cooled via free-convection, unaided by fans or other means.
  3. Provide smart diagnostics for system verification.
  4. Provide testing capability using manual override buttons.
  5. Support [one][two] low-voltage digital communication links of up to 64 ballasts per link capable of NEC Class 1 or Class 2 installation
  6. Connect without interface to wired:
    - a. Occupancy sensors
    - b. Daylight sensors
    - c. IR receivers for personal control
  7. Capable of being controlled via wireless sensors and controls
  8. Connects to Lighting Management Panel via RS485.
  9. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
  10. Contact Closure Input
    - a. Directly accept contact closure input from a dry contact closure or solid-state output without interface to:
      - 1). Activate scenes
        - a) Scene activation from momentary or maintained closure
      - 2). Enable or disable afterhours
        - a) Automatic sweep to user-specified level after user-specified time has elapsed
        - b) System will provide occupants a visual warning prior to sweeping lights to user-specified level
        - c) Occupant can reset timeout by interacting with the lighting system
      - 3). Activate or deactivate demand response (load shed)
        - a) Load shed event will reduce lighting load by user-specified amount

11. Emergency Contact Closure Input
  - a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
  - b. Disable control operation until emergency signal is cleared.

## 2.11 [ECOSYSTEM] TOTAL LIGHT MANAGEMENT CONTROL MODULE

- A. Control module product QSN-2ECO-PS120.
  1. Mechanical: Listed to UL 508 as industrial control equipment.
  2. Delivered and installed as a UL listed factory assembled panel.
  3. Panels passively cooled via free-convection, unaided by fans or other means.
  4. Ten fused 30W (60W peak) 24VDC outputs provide power to [QS] shades, drapery drive units, keypads, and accessories.
  5. Provide power for 10 to 30 shades dependent on shade dimensions.
  6. Provide smart diagnostics for system verification.
  7. Provide testing capability using manual override buttons
  8. Support two low-voltage digital communication links of up to 64 ballasts per link capable of NEC Class 1 or Class 2 installation
- B. Connection to the following without an interface device:
  1. Occupancy sensors
  2. Daylight sensors
  3. IR receivers for personal control
- C. Connects to lighting management panel via RS485.
- D. LED status indicators confirm communication with occupancy sensors, daylight sensors and IR receivers.
- E. Contact closure input: Directly accept contact closure input from a dry contact closure or solid-state output without interface to accomplish the following:
  1. Activate scenes (momentary or maintained closure)
  2. Enable or disable afterhours
    - a. Automatic sweep to user-specified level after user-specified time has elapsed
    - b. System will provide occupants a visual warning prior to sweeping lights to user-specified level
    - c. Occupant can reset timeout by pressing a button on a control station
  3. Activate or deactivate demand response (load shed). Load shed event will reduce lighting load by user-specified amount.
- F. Emergency Contact Closure Input
  1. Turn all zones to full output during emergency state via direct contact closure input from UL 924 Listed Emergency Lighting Interface, security system or fire alarm system
  2. Disable control operation until emergency signal is cleared.

## 2.12 ECOSYSTEM DIMMING BALLAST AND SWITCHING MODULES

- A. Product: [C5-BMF-2A], [C5-BMJ-16A], [C5-XPJ-16A]
- B. General
  1. Continuous 3-Wire signal dimming to Lutron 3-Wire electronic dimming ballast.
  2. Utilize air gap off to disconnect the load from line supply.
  3. Connect without interface to:
    - a. Occupant sensor (motion detector).
    - b. Daylight sensor.
    - c. Personal control input (wall station or infrared receiver).
  4. Generate digital communication commands to distribute ballast and sensor data on the digital bus.

5. If power is interrupted and subsequently returned, lights automatically return to the setting prior to power interruption.
  6. Each ballast responds independently to:
    - a. Up to 32 occupant sensors.
    - b. Up to 64 personal control inputs.
    - c. 2 daylight sensors.
  7. Unique internal reference number visibly displayed on module cover.
  8. Averages 2 independent daylight harvesting inputs internally.
  9. Responds to digital load shed command
    - a. Sets high end trim.
    - b. Automatically scales light output proportional to load shed command.
      - 1). Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by 3 percent to 27 percent.
  10. Electrical: Dimmer to meet limited short circuit test as defined in UL 20.
  11. Provide integral fault protection to prevent ballast module failure in the event of a mis-wire.
- C. [2 Amp (BMF) 3-Wire Ballast Module
1. Ballast module to integrate up to 2 amps of Lutron 3-wire electronic dimming ballast into an EcoSystem control system as a single zone.]
- D. [16 Amp (BMJ) 3-Wire Ballast Module
1. Ballast module to integrate up to 16 amps of Lutron 3-wire electronic dimming ballast into an EcoSystem control system as a single zone.
  2. Module to integrate up to 16 amps of switched high intensity discharge lighting load (HID) into an EcoSystem control system as a single zone.]
- E. [16 Amp (XPJ) Switching Ballast Module
1. Module to integrate up to 16 amps of high in-rush lighting load (magnetic fluorescent ballast, electronic fluorescent ballast, HID, incandescent, magnetic low-voltage, electronic low-voltage, neon/cold cathode and motor loads) into an EcoSystem control system as a single zone.]

## 2.13 LIGHTING MANAGEMENT HUB

- A. Provide Lighting Management Hub in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.
- B. Enables [Q-Admin] Light Management software to control and monitor EcoSystem dimming ballast, EcoSystem modules, Power Panels and GRAFIK Eye QS lighting controllers.
  1. Lighting Management Hub utilizes Ethernet connectivity to Q-Manager server utilizing one of the following methods:
    - a. Dedicated network
    - b. Dedicated VLAN
    - c. Shared network with Building Management System (BMS)
    - d. Corporate network where managed switches are configured to allow multicasting and use of IGMP
- C. Integrates control station devices, power panels, shades, preset lighting controls, and external inputs into a single customizable lighting control system with:
  1. Multiple fail safe mechanisms
    - a. Power failure detection via LUT-ELI
    - b. Miswire protection - lights go to full on if EcoSystem ballast wires are shorted
    - c. Distributed architecture provides fault containment. Single hub failure or loss of power does not compromise lights and shades connected to other Light Management Hubs.

2. Manual overrides
  3. Automatic control
  4. Central computer control and monitoring
  5. Integration with BAS via BACnet
- D. Astronomical time clock.
- E. Maintains a backup of the programming in a non-volatile memory capable of lasting more than ten years without power.
- F. [BACnet Integration License]
1. Provide ability to communicate by means of BACnet IP communication to Lutron Quantum system from a user-supplied 10BASE-T or 100BASE-T Ethernet network.
  2. Supplier to be BACnet Test Laboratory (BTL) Certified
  3. Each Lighting Management Panel processor requires license for BACnet integration.
  4. Basic BACnet integration license
    - a. The BACnet integrator can command:
      - 1). Area light output
      - 2). Area enable or disable afterhours mode
      - 3). Area load shed level
      - 4). Area load shed enable/disable
      - 5). Area shade group presets
    - b. The BACnet integrator can monitor:
      - 1). Area on/off status
      - 2). Area occupancy status
      - 3). Area fault
      - 4). Area load shed status
      - 5). Area instantaneous energy usage
      - 6). Area shade group presets

#### **2.14 LIGHT MANAGEMENT SYSTEM COMPUTER [Q-MANAGER]**

- A. Laptop
1. Used for occasional programming, monitoring, and control of digital network lighting controls.
  2. Computer shall be provided by the lighting control system manufacturer.
  3. Computer software preinstalled and tested prior to shipping.
- B. Server
1. Rack mountable server (Dell R710 or approved equal) shall be provided by the lighting control system manufacturer.
  2. Provide lighting control software preinstalled and tested prior to shipping.
  3. Used for 24 hour per day, 7 day per week programming, monitoring, control, and data logging of digital network lighting controls.
  4. Used to handle client machine request in multi-computer systems.

#### **2.15 LIGHTING MANAGEMENT SYSTEM SOFTWARE**

- A. Provide system software license and hardware that is designed, tested, manufactured, and warranted by a single manufacturer.
- B. Configuration Setup – Q-Design
1. Used to make system programming and configuration changes
  2. Windows based, capable of running on either central server or a remote client over TCP/IP connection
  3. Allow user to:
    - a. Capture system design.
      - 1). Geographical Layout
      - 2). Load Schedule Zoning

- 3). Shade Grouping
  - 4). Equipment Schedule
  - 5). Equipment assignment to lighting management panels
  - 6). Daylighting design
  - b. Define the configuration for the following in each area:
    - 1). Lighting Scenes
    - 2). Shade Group Presets
    - 3). Control Station Devices
    - 4). Interface and Integration Equipment
    - 5). Occupancy/After Hours
    - 6). Partitioning
    - 7). Daylighting
    - 8). Emergency Lighting
    - 9). Night Lights
  - c. Start-up
    - 1). Addressing
    - 2). Daylighting
- C. Control and Monitor [Q-Admin]
- 1. Basic System View
    - a. The Q-Admin system navigation and status reporting is performed using a tree view of the building.
  - 2. Graphical Floorplan View
    - a. Provide Q-Admin system navigation and status reporting performed using customized CAD based drawings. Provide Pan and Zoom feature allows for easy navigation.
  - 3. Control of Lights & Shades
    - a. Area lights can be monitored for on/off status.
    - b. All lights in an area can be turned on/off or sent to a specific level.
    - c. For areas that have been zoned, these areas may be sent to a predefined lighting scene, and individual zones may be controlled.
    - d. Area lighting scenes can be modified in real-time, changing the levels zones go to when a scene is activated.
    - e. High and Low end of area lighting can be tuned/trimmed
    - f. Area shades can be monitored for current preset or position.
    - g. Area shades can be opened/closed, sent to a preset, or sent to a specific position.
  - 4. Occupancy
    - a. Area occupancy can be monitored.
    - b. Area occupancy can be disabled to override occupancy control or in case of occupancy sensor problems.
    - c. Area occupancy settings including level lights turn on to when area is occupied, and level lights turn off to when area is unoccupied can be changed in real-time.
  - 5. Daylighting
    - a. Daylighting can be enabled/disabled. This can be used to override the control currently taking place in the space.
    - b. Daylight target levels can be changed for each daylit area. This is particularly useful when new departments move into a space.
  - 6. Load Shedding
    - a. Load shedding allows the building manager to monitor whole building lighting power usage and apply a load shed reduction to selected areas, thereby reducing a building's power usage.
  - 7. Scheduling
    - a. Schedule time of day and astronomic time clock events to automate functions for lights and shades.

8. Reporting allows the building manager to gather real-time and historical information about the system as follows:
  - a. Energy Reports - Show a comparison of cumulative energy used over a period of time for one or more areas
  - b. Power Reports - Show power usage trend over a period of time for one or more areas.
  - c. Activity Report – Shows what activity has taken place over a period of time for one or more areas. Activity includes occupant activities (i.e. areas going occupied/unoccupied, wall controls being pressed), building manager operation (controlling/changing areas using the control & monitor tool), and device failures (keypads, ballasts, etc. not responding).
  - d. Lamp Failure Report – Shows which areas are currently reporting lamp failures.
  - e. Metered Energy Reports - Show a comparison of cumulative energy used over a period of time for one or more meter groups
  - f. Metered Power Reports - Show power usage trend over a period of time for one or more meter groups.
9. Diagnostics
  - a. Diagnostics allows the building manager to check on the status of all equipment in the lighting control system. Devices will be listed with a reporting status of OK, missing, or unknown.
10. Administration
  - a. Users – Allows new user accounts to be created and existing user accounts to be edited.
  - b. Publish Graphical Floor plan – Allows admin user to publish new graphical floor plan files, allowing users to monitor the status of lights, occupancy of areas, and daylighting status.
  - c. Back-up Project Database – Allows admin user to backup the project database. The project database holds all the configuration information for the system, including keypad programming, area scenes, daylighting, occupancy programming, emergency levels, night lights, and timeclock. The Control and Monitor tool can be used to adjust some of these settings, and thus it is important to back-up the project database prior to changing settings in the Design and Setup tool.
11. Publish Project Database – Allows the admin user to send a new project database to the server and download the new configuration to the system. The project database holds all the configuration information for the system, including keypad programming, area scenes, daylighting, occupancy programming, emergency levels, night lights, and timeclock.

## **2.16 PERSONNA PC – PERSONAL WEB BASED CONTROL**

- A. The user may use a web browser on their personal PC, laptop, or some mobile device (supporting 1024 x 768 resolution) to control one or more lights and shades in their area.
  1. The user may select between full on, off, or a favorite light level
  2. The user may raise/lower the currently selected lighting level in the area.
  3. The user may select open, closed, or a favorite shade position
  4. The user may raise/lower a selected shade group in the area.
- B. Personna PC shall support up to 10,000 users
- C. Each user shall have a login name and password sent from administrator via email when user account created
- D. Shall support the following browsers: Microsoft Internet Explorer Version 7, Microsoft Internet Explorer Version 8, Microsoft Internet Explorer Version 9, Mozilla Fire Fox Version 3.6.12, Apple Safari Version 4.0, Apple Safari Version 4.5, Google Chrome Version 8.0

## 2.17 WIRED QS CONTROL STATIONS

- A. Shall control any device that is part of the Lutron System.
- B. SeeTouch series control stations.
- C. Stations shall use RS485 wiring for low voltage communication.
- D. Functionality:
  - 1. Pressing any button shall cause LEDs to immediately illuminate.
  - 2. LEDs shall reflect the system status. LEDs shall remain illuminated if the button press was properly processed or the LEDs shall turn off if the button press was not processed.
  - 3. Controller shall allow for easy reprogramming without replacing the unit.
- E. Color as selected by Architect.
- F. Provide faceplates with concealed mounting hardware.
- G. Engrave control stations in English with appropriate button, zone and scene engraving descriptions.
- H. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
- I. Software Configuration:
  - 1. Customizable control station device button functionality:
    - a. Buttons can be programmed to perform single defined action.
    - b. Buttons can be programmed to perform toggle actions
    - c. Buttons can be programmed to perform defined action on press and defined action on release.
- J. Control Station device LEDs shall support logic that defines when it is illuminated.
  - 1. Scene logic (logic is true when all zones are at defined levels).
  - 2. Room logic (logic is true when at least one zone is on).
  - 3. Pathway (logic is true when at least one zone is on).

## 2.18 WIRED IR CONTROL STATIONS [ECOSYSTEM 4B MODEL CC-4BRL-WH]

- A. Stations shall utilize Class 2 (low voltage) wiring and shall be capable of being replaced without reprogramming.
- B. Color as selected by Architect.
- C. Provide faceplates with concealed mounting hardware.
- D. Software Configuration:
  - 1. Customizable control station device button functionality:
    - a. Buttons can be programmed to perform single defined action.

## 2.19 WIRED QS KEYSWITCH [QS KEYSWITCH]

- A. Shall control any device that is part of the Lutron System.
- B. Operation:
  - 1. 3 Position, momentary, center position key removal [QSW2-KSI-3MOC]
  - 2. 3 Position, maintained, center position key removal [QSW2-KSI-3MAC]
  - 3. 2 Position, maintained center position key removal [QSW2-KSI-2MAC]
  - 4. 2 Position, maintained any position key removal [QSW2-KSI-2MAA]
- C. Switch shall use RS485 wiring for low voltage communication.
- D. Stations shall utilize Class 2 (low voltage) wiring and shall be capable of being replaced without reprogramming.
- E. Color as selected by Architect.
- F. Provide faceplates with concealed mounting hardware.

- G. Engrave switch in English with appropriate button, zone and scene engraving descriptions.
- H. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
- I. Software Configuration:
  - 1. Customizable control station device button functionality:
    - a. Key positions shall be programmable to perform single defined action.
- J. Keys shall be standard universal key for keyswitch stations.

## 2.20 LOW VOLTAGE CONTROL INTERFACES

- A. Contact Closure Interface: Lutron Model QSE-IO.
  - 1. The contact closure input device will accept both momentary and maintained contact closures.
  - 2. The contact closure output device can be configured for maintained or pulsed outputs.
- B. Contact Closure Input Interface; [Lutron QS seeTouch keypads Model QSWS2]:
  - 1. The contact closure input device will accept both momentary and maintained contact closures.
- C. RS232 and Ethernet Interface; [Lutron Model QSE-CI-NWK-E]
  - 1. Provide ability to communicate via ethernet or RS232 to audiovisual equipment, touchscreens, etc.
  - 2. Provide control of:
    - a. Lights scene selections.
    - b. Shade Group Presets.
    - c. Fine-tuning of shade preset or light scenes levels with raise/lower.
    - d. Simulate system wall station button presses and releases.
  - 3. Provide status monitoring of:
    - a. Light scene-status.
    - b. Shade Group status.
    - c. Wall station button presses and releases.
    - d. Wall station LEDs.
- D. Wired and Wireless Sensor Module:
  - 1. Product: [QSM2-4W-C]
  - 2. Provide wired inputs for:
    - a. Occupancy sensors
    - b. Daylight sensors
    - c. IR receivers for personal control
    - d. Digital Ballast Control Stations
  - 3. Wireless Integration
    - a. Provide wireless communication inputs for:
      - 1). Occupancy sensors
      - 2). Daylight sensors
      - 3). Wireless Controller
    - b. Provide RF range of 18 meters (60 feet) line of sight or 9 meters (30 feet) through typical construction materials.
    - c. RF frequency of 434 MHz
  - 4. Communicate sensor information to wired QS link for use by compatible devices.
- E. Wired Sensor Module
  - 1. Product: [QSMX-4W-C]
  - 2. Provide wired inputs for:
    - a. Occupancy sensors
    - b. Daylight sensors

- c. IR receivers for personal control
  - d. Digital Ballast Control Stations
- 3. Communicate sensor information to wired QS link for use by compatible devices.
- F. Wireless Sensor Module
  - 1. Product: [QSM2-XW-C]
  - 2. Wireless Integration
    - a. Provide wireless communication inputs for:
      - 1). Occupancy sensors
      - 2). Daylight sensors
      - 3). Wireless Controller
    - b. Provide RF range of 18 meters (60 feet) line of sight or 9 meters (30 feet) through typical construction materials
    - c. RF frequency of 434 MHz
  - 3. Communicate sensor information to wired QS link for use by compatible devices.

## 2.21 SENSORS

- A. Wired Ceiling and Wall Mount Occupancy/Vacancy Sensors.
  - 1. Sensing mechanism:
    - a. Dual technology
      - 1). Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
      - 2). Utilize an operating frequency of 32kHz or 40kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
  - 2. Sensors shall turn off or reduce lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space
  - 3. Sensor shall accommodate all conditions of space utilization and all irregular work hours and habits.
  - 4. Sensors shall be UL listed.
  - 5. Sensors shall be fully adaptive and adjust their sensitivity and timing to ensure optimal lighting control for any use of the space
  - 6. Sensors shall have field adjustable controls for time delay and sensitivity to override any adaptive features.
  - 7. Power failure memory:
    - a. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and learned parameters saved in protected memory shall not be lost.
  - 8. Provide all necessary mounting hardware and instructions.
  - 9. Sensors shall be Class 2 devices.
  - 10. Indicate viewing directions on mounting bracket for all ceiling mount sensors.
  - 11. Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
  - 12. Lutron LOS-CDT-2000 or approved equal.
- B. Sensor Power Packs
  - 1. Control wiring between sensors and control units shall be installed in conduit.
  - 2. For ease of mounting, installation and future service, power pack(s) shall be able to mount through a 1/2" knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of three (3) sensors.
  - 3. Power pack shall be plenum rated
- C. Infrared Receivers
  - 1. Use Class 2 wiring for low voltage communication
  - 2. Can be replaced without reprogramming

3. 360 degree reception of wireless infrared remote controls
  4. Immediate local LED response upon reception of hand held transmitter communication
  5. Constructed with plastic meeting UL94 HB
- D. Interior Daylight Sensors
1. Use Class 2 wiring for low voltage communication
  2. Can be replaced without reprogramming
  3. Open-loop basis for daylight sensor control scheme
  4. Stable output over temperature from 0° to 40° C
  5. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection
  6. Provide linear response from 0 to 500 foot-candles
  7. Integral IR receiver for programming
  8. Constructed with plastic meeting UL94 HB

## 2.22 WIRELESS CEILING OCCUPANCY/VACANCY SENSORS

- A. Product: [LRF2-OCR2B-P-WH]
- B. Wireless Ceiling Sensors shall:
1. Provide 360 degree coverage range
  2. Provide optional customizable mask to block off unwanted viewing areas
  3. Have a battery lifetime of a minimum of 10 years when installed per manufacturer's instructions.
  4. Communicate directly to compatible RF receiving devices through use of a radio frequency require external communications link.
  5. No external power packs, power wiring, or communication wiring are required
  6. Provide a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
  7. Have a multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
  8. Utilize Infrared as its sensing mechanism coupled with Lutron XCT™ Technology for sensing fine motions. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
  9. Utilize Lutron Clear Connect Technology to ensure reliable RF communications
  10. RF frequency of [434 MHz]
  11. Have optional, readily accessible, user adjustable controls for timeout, automatic/manual-on, and sensitivity.
  12. Have a test mode that provides a visual indication from the face of the unit to verify correct sensor placement, coverage and operation.
  13. Provide RF range between sensor and compatible RF receiving device(s) of 60 feet (18 meters) line of sight or 30 feet (9 meters) through typical construction materials
  14. Turn off lighting automatically after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Adjustable timeout shall be available for [1], [5], [15], [30] minutes.
  15. System provides ability to add additional timeout system wide without having to make local adjustments on sensor
  16. System capable of providing the following occupied and unoccupied actions
    - a. Area level – from 0-100%
    - b. Preset area scene
    - c. Daylighting
  17. System can be programmed to change the occupied and unoccupied actions based on button presses, timeclock, or BACnet
    - a. System can be configured to apply changes immediately or change of state of occupancy

18. System provides ability to group multiple sensors such that when one sensor seeing occupancy sends the area occupied, but all sensors must trip to go unoccupied.
    - a. Further grouping of areas can be achieved such that when one area goes occupied, multiple areas go occupied using the same control logic
    - b. System provides occupancy group 1-way dependency feature, which provides the ability to turn dependent areas (example hallways) on based on one of many other adjacent controlling areas (example private offices) going occupied. For the dependent area to turn off, all controlling areas must be unoccupied. The dependent area going occupied does not make the controlling areas go occupied.
  19. System provides the ability to configure areas so that they respond to occupancy sensors only if the area is in an unoccupied state (for when a control station may be hit before the occupancy sensor detects occupancy)
  20. Comply with the limits for a Class B device, pursuant to part 15 of the FCC rules.
  21. Power failure memory:
    - a. Sensors incorporate non-volatile memory. Should power be interrupted and subsequently restored, sensor settings saved in protected memory shall not be lost.
  22. Provide a grace period per Title 24 requirements to send lights to previous level when motion is detected within 30 seconds of going unoccupied
- C. Mounting:
1. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, compressed fiber ceilings.
  2. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
  3. Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method shall be designed for easy, damage-free removal.
  4. Ceiling-mount wireless occupancy/vacancy sensors using passive infrared technology shall have a customizable mask to block off unwanted viewing areas.
  5. Sensor lens shall illuminate during test mode when motion is detected to allow installer to verify coverage prior to permanent mounting.
- D. Wireless occupancy/vacancy sensor can be programmed to operate as an occupancy sensor (automatic-on and automatic-off functionality), an occupancy sensor with low light feature (automatic-on when less than 1 fc (10 lux) of ambient light available and automatic-off functionality), or a vacancy sensor (manual-on and automatic-off functionality).
- E. A vacancy-only model shall be available to meet California Title 24 Energy Efficiency Standard requirements.

## 2.23 HAND HELD PROGRAMMER

- A. Provide hand held programmer for programming the system with the following features:
1. Wireless programming for all system settings.
  2. Secured via pass code.
  3. Allows for replacement of single or multiple ballasts via serial number recognition of non-functioning ballast.
  4. Only operates as a lighting control device.
  5. Non-volatile memory stores lighting control software for minimum of 10 years for power loss.
  6. Programmer stores non-system specific configuration settings.

## **2.24 ACCESSORIES**

- A. Emergency Lighting Interface; Lutron LUT-ELI
  - 1. Provides total system listing to UL924 when used with Lutron Quantum system.
  - 2. Senses all three phases of building power.
  - 3. Provides an output to power panels or Digital Ballast Interfaces if power on any phase fails and sends all lights controlled by these devices to [an emergency light level setting] [100 percent intensity]. Lights to return to their previous intensities when normal power is restored.
  - 4. Accepts a contact closure input from a fire alarm control panel.
- B. Infrared Transmitters:
  - 1. Provide wireless remote control.
  - 2. Designed for use in conjunction with compatible infrared receiver and lighting control; compatibility dependent on that receiver, not transmitter.
  - 3. Operate up to 15 meters (50 feet) within line-of-sight to that receiver.
  - 4. "Learnable" by other variable frequency remote controls.

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 INSTALLATION**

- A. Install equipment in accordance with manufacturer's installation instructions.
- B. Provide complete installation of system in accordance with Contract Documents.
- C. Install server in telecom rack in Telecom 217.
- D. Provide dedicated network between Q-Manager computer and Quantum Lighting Management Panel(s).
- E. Define each dimmer's load type and set control functions.
- F. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- G. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaires.
- H. Season lamps at full intensity according to lamp manufacturer's recommendation.
- I. Systems Integration
  - 1. Schedule a meeting between Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.

### **3.3 SOURCE QUALITY CONTROL**

- A. Perform full-functional testing on all completed assemblies. Representative testing is not acceptable.
- B. Perform full-function testing on 100 percent of the ballasts at the factory. Submit test results for approval.
- C. Burn-in dimming assemblies and panels at full load for two hours.

**3.4 INITIAL SCENE SETTINGS**

- A. Program the initial lighting control scenes for the specific rooms noted as described in the following tables.
- B. Coordinate final descriptions and scenes with DEPARTMENT prior to programming.

**CLASSROOM 113 LIGHTING SCENES AND ZONE SCHEDULE**

#	Description	Lighting Control Zones					Screen Control	
		"a"	"b"	"c"	"d"	"e"	Projector Screen(s)	Projector Screen(s)
1	All Fixtures On	90%	90%	90%	n/a	n/a	n/a	n/a
2	A/V Presentation	50%	0%	0%	n/a	n/a	n/a	n/a
3	Reduced Level	50%	50%	50%	n/a	n/a	n/a	n/a
4	Indirect	0%	90%	90%	n/a	n/a	n/a	n/a
5	Off	0%	0%	0%	0%	n/a	n/a	n/a

**LECTURE HALL 154 LIGHTING SCENES AND ZONE SCHEDULE**

#	Description	Lighting Control Zones					Screen Control	
		"a"	"b"	"c"	"d"	"e"	Projector Screen 1	Projector Screen 2
1	All Fixtures On	90%	90%	90%	90%	90%	Up	Up
2	A/V Presentation	25%	0%	0%	0%	90%	Down	Down
3	Live Presentation	25%	25%	90%	25%	90%	Up	Up
4	Reduced Level	50%	50%	50%	50%	90%	Up	Up
5	Off	0%	0%	0%	0%	n/a	Up	Up

**CONFERENCE ROOM 245 LIGHTING SCENES AND ZONE SCHEDULE**

#	Description	Lighting Control Zones					Screen Control	
		"a"	"b"	"c"	"d"	"e"	Projector Screen(s)	Projector Screen(s)
1	All Fixtures On	90%	90%	90%	n/a	n/a	n/a	n/a
2	A/V Presentation	50%	0%	0%	n/a	n/a	n/a	n/a
3	Reduced Level	50%	50%	50%	n/a	n/a	n/a	n/a
4	Indirect	0%	90%	90%	n/a	n/a	n/a	n/a
5	Off	0%	0%	0%	n/a	n/a	n/a	n/a

**CONFERENCE ROOM 255 LIGHTING SCENES AND ZONE SCHEDULE**

#	Description	Lighting Control Zones					Screen Control	
		"a"	"b"	"c"	"d"	"e"	Projector Screen(s)	Projector Screen(s)
1	All Fixtures On	90%	90%	n/a	n/a	n/a	n/a	n/a
2	A/V Presentation	50%	0%	n/a	n/a	n/a	n/a	n/a
3	Reduced Level	50%	50%	n/a	n/a	n/a	n/a	n/a
4	Indirect	0%	90%	n/a	n/a	n/a	n/a	n/a
5	Off	0%	0%	n/a	n/a	n/a	n/a	n/a

**3.5 SYSTEM STARTUP**

- A. Provide factory-certified field service engineer to a site visit to ensure proper system installation and operation under following parameters:
  - 1. Qualifications for factory-certified field service engineer:
    - a. Minimum experience of 2 years training in the electrical field.
    - b. Certified by the equipment manufacturer on the system installed.
  - 2. Make first visit prior to installation of wiring. Review:
    - a. Low voltage wiring requirements.
    - b. Separation of power and low voltage/data wiring.
    - c. Wire labeling.
    - d. Lighting Management Panel locations and installations.
    - e. Control locations.
    - f. Computer jack locations.
    - g. Load circuit wiring.
    - h. Network wiring requirements.
    - i. Connections to other equipment and other Lutron equipment.
    - j. Installer responsibilities.
    - k. Power Panel locations.

3. Make second visit upon completion of installation of Network Lighting Control System:
    - a. Verify connection of power wiring and load circuits.
    - b. Verify connection and location of controls.
    - c. Energize Lighting Management Panels and download system data program.
    - d. Address devices.
    - e. Verify proper connection of panel links (low voltage/data) and address panel.
    - f. Download system panel data to dimming/switching panels
    - g. Check dimming panel load types and currents and supervise removal of by-pass jumpers.
    - h. Verify system operation control by control.
    - i. Verify proper operation of manufacturers interfacing equipment.
    - j. Verify proper operation of manufacturers supplied PC and installed programs.
    - k. Configure initial groupings of ballast for wall controls, daylight sensors and occupant sensors.
    - l. Initial calibration of sensors.
    - m. Obtain sign-off on system functions.
  4. Make third visit to demonstrate and educate DEPARTMENT on system capabilities, operation and maintenance.
- B. Startup
1. Q-Admin configuration - Naming and association of areas, lighting zones, shade zones.
- C. Training of Customer representatives for Q-Admin. Training shall include:
1. Configuration software used to make system programming and configuration changes
  2. Control and monitor
  3. Personna PC
- D. Tech Support
1. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

### **3.6 FIELD QUALITY CONTROL**

- A. Manufacturer Services
1. Provide on-site meeting with Lighting Control System Manufacturer and Engineer of Record to make required lighting adjustments to system for conformance with original design intent. Provide a minimum of four days at six hours per day of support.

### **3.7 TRAINING**

- A. Provide one full day walkthrough by a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent and Owner personnel.
- B. Provide two additional days of on-site system training to Owner personnel.

### **3.8 SYSTEM OPTIMIZATION SITE VISIT**

- A. Provide two full days by a factory certified Field Service Engineer approximately 6 months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will match the use of the facility.

### **3.9 MAINTENANCE**

- A. Capable of providing on-site service support within 24 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.

- B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.

**END OF SECTION 26 27 49**

**SECTION 26 29 13**  
**DISTRIBUTION SWITCHBOARDS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes: This section describes general provisions, products, and methods of execution relating to Distribution Switchboards rated 600 volts and less approved for use on this project. Type, size, ratings, etc., shall be as shown on the plans and in accordance with U.L. and NEMA standards.
- B. Scope: Provide factory assembled, metal enclosed switchboards for distribution and control of power from incoming line terminals to outgoing feeder terminals, installed and tested in place.
- C. Related Requirements:
  - 1. Section 26 26 10 – Surge Protective Devices.
  - 2. Section 26 26 20 – Overcurrent Protective Devices.

**1.2 REFERENCES**

- A. The switchboard(s) and overcurrent protection devices referenced herein shall be designed and manufactured according to latest revision of the following specifications:
  - 1. ANSI/NFPA 70 - National Electrical Code (NEC).
  - 2. ANSI/IEEE C12.1 - Code for Electricity Metering.
  - 3. ANSI C39.1 - Electrical Analog Indicating Instruments.
  - 4. ANSI/IEEE C57.13 - Instrument Transformers.
  - 5. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 6. NEMA KS 1 - Enclosed Switches.
  - 7. NEMA PB 2 - Deadfront Distribution Switchboards.
  - 8. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
  - 9. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.
  - 10. UL 50 - Cabinets and Boxes.
  - 11. UL 98 - Enclosed and Dead Front Switches.
  - 12. UL 489 - Molded Case Circuit Breakers.
  - 13. UL 891 - Dead-Front Switchboards.
  - 14. UL 943 - Ground Fault Circuit Interrupters.
  - 15. UL 977 - Fused Power Circuit Devices.
  - 16. UL 1283 – Safety for Electromagnetic Interference Filters.
  - 17. UL 1449 – Surge Protective Devices.
  - 18. CSA 22.2 No. 5 - M1986 Molded Case Circuit Breakers.
  - 19. Federal Specification W-C-375 - Circuit breakers, molded case, branch circuit and service.
  - 20. Federal Specification W-C-870 - Fuse holders (For plug and enclosed cartridge fuses).
  - 21. Federal Specification W-S-865 - Enclosed Knife Switch.

**1.3 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Submit product data for each type of switchboard, overcurrent protective device, surge protective device, ground fault protector, accessory, and component indicated. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

- C. Shop drawings:
  - 1. Prepare shop drawings to ensure that equipment proposed will fit into space available on the Drawings, while providing all required clearances and working spaces.
  - 2. Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data. Submit shop drawings for each switchboard and related equipment.
  - 3. Indicate front and side enclosure elevations with overall dimensions, conduit entrance locations and requirements, nameplate legends, one line diagrams, equipment schedule and switchboard instrument details.
  - 4. Submit mimic bus diagram.
- D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturers installed wiring and field installed wiring, and between components provided by the manufacturer and those provided by others.
- E. Quality Control Submittals:
  - 1. Test Reports: Submit field Quality Control test reports.
- F. Contract Closeout Submittals:
  - 1. Operation and Maintenance Data: Submit Operation and Maintenance Data for switchboards to include in operation and maintenance manuals specified in Section 26 00 00 and Division 1. Refer to Manuals below for additional requirements.
  - 2. Warranty Data: Submit manufacturer's standard warranty documents.

#### **1.4 QUALITY CONTROL**

- A. Distribution Switchboards shall be of the latest approved design as specified in U.L. standard 891 and as manufactured by a nationally recognized manufacturer and shall be listed by the Underwriters' Laboratory and bear the UL label.
- B. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors installed in the State of Alaska must be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.
- C. Electrical Components, Devices, and Accessories: Electrical components, devices, and accessories shall be listed and labeled as defined in NEC, Article 100, by an inspecting and testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### **1.5 ENVIRONMENTAL REQUIREMENTS**

- A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

#### **1.6 WARRANTY**

- A. Warrant all components, parts and assemblies against defects in materials and workmanship for a period of 12 months after final acceptance.

#### **1.7 MANUALS**

- A. Provide two sets of installation instructions with each switchboard. Installation instructions shall be easily identified and affixed within the incoming or main section of the lineup.
- B. Furnish Operation and Maintenance Manuals for each switchboard system in accordance with Section 26 00 00 and Division 1 requirements. Provide number of sets as required in Division 1, however if not specified, provide a minimum of two (2) complete sets for each switchboard.

## **PART 2 - PRODUCTS**

### **2.1 BASIS OF DESIGN**

- A. The Basis of Design is equipment from Square D by Schneider Electric to set a standard for quality. Equipment from General Electric, Cutler Hammer, Siemens Energy & Automation or alternative systems will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the specification.

### **2.2 SWITCHBOARDS - GENERAL**

- A. Switchboards shall have the following features:
  - 1. Front Accessible
  - 2. Main Devices shall be:
    - a. Fixed, individually mounted
  - 3. Branch Devices shall be:
    - a. Fixed individually mounted branches for breakers >1200 amperes. Panel mounted plug on branches 1200 amperes and less.
  - 4. Sections shall be front and rear aligned.
- B. Nominal System Voltage: Nominal system voltage shall be 480Y/277 volts.
- C. Main Bus Continuous: As noted on drawings.
- D. Short Circuit Current Rating: As noted on drawings.
- E. Enclosure Type: Provide Type 1 – General Purpose steel enclosure in compliance with UL 891.
- F. Enclosure Finish: Provide factory applied finish in manufacturer's standard gray finish over a rust inhibiting primer on treated metal surface.
- G. Barriers: Provide barriers between adjacent switchboard sections.
- H. Auxiliary Sections (if required): Provide auxiliary sections matched and aligned with basic switchboards.
- I. Bus Transition and Incoming Pull Sections (if required): Match and align with basic switchboard.
- J. Front Covers: Front covers shall be screw removable with a single tool and doors shall be hinged with removable hinge pins.
- K. Pull Box on Top of Switchboard (if required)
  - 1. Provide ventilation openings as required to maintain temperature in pull box within same limits as switchboard.
  - 2. Removable covers shall form top, front, and sides. Top covers at rear shall be removable for drilling and cutting.
  - 3. Lace cables using industry approved methods.
- L. Buses and Connections:
  - 1. Group Mounted Feeder Vertical Bus Stack:
    - a. Non-conducting surface films shall be removed during circuit breaker installation by a wiping action of the circuit breaker jaws.
    - b. The design of the circuit breaker jaws and bus stack shall create blow on forces under fault conditions.
    - c. Bolted lap joint connections for feeder breakers shall not be allowed for group mounted feeders.
  - 2. Ground Bus: Size per current NEC and UL 891 Tables 28.1 and 28.2, hard drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch circuit ground conductors.

3. Bus Composition: Silver plated copper. Plating shall be applied continuously to bus work. The switchboard bussing shall be of sufficient cross sectional area to meet UL 891 temperature rise requirements. The phase and neutral through bus shall have an ampacity as indicated in this section or as shown on the Drawings. The neutral shall be of equivalent ampacity as the phase bus bar. Tapered bus is not permitted. Full provisions for the addition of future sections shall be provided. Bussing shall include, but shall not be limited to, necessary hardware to accommodate splicing for future additions.
  4. Isolation Barrier Access Provisions: Permit checking of bus bolt tightness.
- M. Future Provisions: Unused spaces provided shall be fully equipped for future devices, including all appropriate connectors and mounting hardware. Each switchboard shall be provided with distribution section(s) as required to accommodate circuit breakers shown on drawings plus a minimum of 20% future space.
- N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit breaker compartment.

### **2.3 SURGE PROTECTIVE DEVICES (SPD)**

- A. See Section 26 26 10 – Surge Protective Devices

### **2.4 OVERCURRENT PROTECTIVE DEVICES**

- A. See Section 26 26 20 – Overcurrent Protective Devices

### **2.5 POWER AND TRIP HISTORY MONITORING**

- A. System Description:
1. Customer monitoring shall consist of an electronic Circuit Monitor and System Display.
  2. Provide a Square D PowerLogic CM4250 circuit monitor with waveform capture provisions to monitor the main disconnect(s) in each switchboard.
- B. Circuit Monitor Installation:
1. Electronic circuit monitors shall be installed by the switchboard manufacturer.
  2. Control power (current and voltage transformers) and communications wire shall be factory wired and harnessed within the switchboard lineup.
  3. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings shall clearly identify the interconnection requirements including wire type to be used.

### **2.6 CONTROL POWER**

- A. Control Circuits: 120 volts, supplied through secondary disconnecting devices from control power transformer.
- B. Control Power Fuses: Primary and secondary fuses for current limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

### **2.7 IDENTIFICATION**

- A. Mimic Bus: Provide an anodized aluminum or plastic engraved plaque. Arrange in single line diagram format, using symbols and letter designations consistent with final mimic bus diagram. Produce a concise visual presentation of principal switchboard components and connections.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine area to receive switchboard to insure adequate clearance for switchboard installation.
- B. Check that concrete pads are level and free of irregularities.
- C. Start work only after unsatisfactory conditions are corrected.

#### **3.2 INSTALLATION**

- A. Install switchboard in accordance with manufacturer's written instructions, and NEC.
- B. Provide minimum 3 inch high concrete pad with minimum 2 inch reveal on front and sides for mounting switchboard. Concrete pad shall comply with requirements of Division 3 and code requirements.
- C. Provide switchboard sections with adequate lifting means; capable of being rolled or moved into position and bolted directly to floor without use of floor sills.
- D. Level switchboard and securely fasten to floor. Carefully align bus connection before bolting together.
- E. Provide cable supports for all cables entering switchboard from point of entrance to their respective overcurrent devices.
- F. Switchboards shall not be used for pull boxes for wiring not terminating in the switchboard.

#### **3.3 FIELD QUALITY CONTROL**

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and Grounding.
- B. Measure, using a Megger, the insulation resistance of each bus section phase to phase and phase to ground for one minute each, at minimum test voltage of 1000 volts DC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.
- C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- D. Conduct a performance test of the ground-fault protection system in accordance with NEC Article 230.95(C) and the equipment manufacturer's instructions.

#### **3.4 ADJUSTING**

- A. Adjust all operating mechanisms for free mechanical movement per manufacturer specifications.
- B. Tighten bolted bus connections in accordance with manufacturer's instructions.
- C. Adjust circuit breaker trip and time delay settings to values in accordance with the coordination study required under Section 26 26 20 - Overcurrent Protective Devices.

#### **3.5 CLEANING**

- A. Touch up scratched or marred surfaces to match original finish.

**END OF SECTION 26 29 13**

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**SECTION 26 30 00**  
**EMERGENCY STANDBY GENERATION SYSTEM**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. This section describes the scope of work for the Emergency/Standby electric generating system on the project.
- B. Related Sections:
  - 1. 01 91 00 - Commissioning
  - 2. 25 50 00 - Building Automation System
  - 3. 26 00 00 - Electrical General Requirements
  - 4. 26 30 04 - Automatic Transfer Switches

**1.2 SCOPE**

- A. Provide and acceptance test a complete and operable Emergency/Standby electric generating system, including all devices and equipment specified herein, as shown on the Drawings, or required for the service.
- B. The system shall include, but not be limited to, engine-generator, transfer switches, starting batteries, battery charger, remote annunciators, conduit, wire, fittings and accessories required to provide a complete operating system. Units shall be located in accordance with the plans.
- C. Provide the generator system in a weatherproof housing with features, accessories and appurtenances called for in this Section and on the Drawings.
- D. The system shall comply with the applicable requirements of NFPA 110 - Emergency and Standby Power Systems for a Level 2, Type 10, Class 2 system. Provide all features and accessories required.
- E. Prototype tests shall have been performed on a complete and functional unit. Component level type tests will not satisfy this requirement. Prototype testing shall comply with the requirements of NFPA 110.
- F. The system (generator, accessories and enclosure package) shall be listed to UL2200.
- G. The generation system shall be grounded as a "separately derived system" in accordance with NEC Article 250.30(A) for grounded systems.
- H. The work also includes, but is not limited to:
  - 1. Load shed priority and control system to give priority to NEC Article 700 "emergency" loads over "standby" loads and to dynamically manage the standby load according to Department established priorities.
  - 2. Hardwired connection to the Building Automation Control System to provide remote monitoring as specified in Divisions 21, 22 and 23.
  - 3. Generator vibration isolators to meet seismic requirements.
  - 4. Fuel oil transfer system (between above ground storage tank AST-1 and generator sub-base day tank).

**1.3 INTENT OF SPECIFICATIONS**

- A. The intent and purpose of these specifications is to provide a diesel-generator set of the latest commercial type and design. In a standby capacity, it shall be capable of continuous service at rated output for the duration of any utility power failure. The engine and generator shall be the product of one company. It shall be a new, factory assembled and tested set as manufactured by Cummins Power Generation, which is the Basis of Design system shown on

the Drawings. The engine and generator set shall have undergone comprehensive prototype testing to ensure acceptable performance at rated load and power factor.

- B. Alternative systems manufactured by others will be considered providing that sufficient documentation is provided to satisfy the CONTRACTING AGENCY that the equipment meets the requirements of the specification, and that all impacts of substituting an alternate to the Basis of Design have been addressed (performance requirements, space, size, connection requirements, etc.).
- C. Provide the necessary controls and accessories to the extent that this equipment, in conjunction with the diesel engine generator set, comprises a complete operating package for installation at 100 feet above sea level in an ambient temperature of 90 degrees F. maximum, -20 degrees F. minimum.
- D. The generator vendor shall review the Contract Documents to become informed regarding loads served by the system. Equipment provided shall be compatible with loads served under all operational scenarios.

#### 1.4 RATING

- A. Rating of the diesel engine generator set shall be based on operation of the set when equipped with all necessary operating accessories such as radiator, fan, air cleaners, lubricating oil pump, fuel transfer pump, fuel injector pump, jacket water pump, governor, charging alternator, alternating current generator, and exciter regulator.
- B. The diesel engine generator set shall be capable of producing the kW rating as shown on the Drawings at 0.8 power factor continuously for standby power applications at the specified ambient and altitude conditions. The output voltage shall be 480 volts, 4-wire, 3 phase, 60 Hertz.
- C. Engines with special fuel requirements are not acceptable. Engine shall obtain rated output with No. 1 or No. 2 diesel or heating fuel.
- D. Engine shall be certified to U.S. EPA Non-road Source Emissions Standards, 40 CFR 89, Tier 2.

#### 1.5 QUALITY CONTROL

- A. Provide system designed and built in accordance with NEMA, IEEE, ANSI Standards, and in accordance with NFPA and the electrical codes.

#### 1.6 SUBMITTALS

- A. Provide Submittals for products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Provide submittal data with the following information:
  - 1. Manufacturer's product literature and performance data, sufficient to verify compliance with specification requirements.
  - 2. Drawings and/or literature describing diesel engine generator set(s), switchgear, controls, and other auxiliary equipment to be provided.
  - 3. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
  - 4. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point to point manner.
  - 5. Manufacturer's installation instructions.
  - 6. Drawings of the diesel generator set offered hereunder.
  - 7. Layout Drawings of the module (housing) showing all equipment and demonstrating all required working clearances.
  - 8. The following data in tabulated form:

- a. Make of engine.
- b. Number of cylinders.
- c. Bore, inches.
- d. Stroke, inches.
- e. Piston displacement, cubic inches.
- f. Piston speed, feet per minute, at rated RPM.
- g. Make and type of generator.
- h. Generator electrical rating, kVA or kW @ .8 power factor.
- i. Exciter type.
- j. Alternator insulation class and temperature rise.
- k. Alternator direct-axis transient reactance (X'd).
- l. Alternator sub-transient reactance at standby rating of genset.
- m. Total harmonic distortion of AC voltage at full load at 0.8 power factor, line-to-line and line-to-neutral.
- n. Parts and service support.
- o. Engine manufacturer's certified engine BHP curve and certified genset fuel consumption curve.
- p. Auxiliary equipment showing all options.
- q. Manufacturer's installation instructions.

#### 1.7 DEPARTMENTS MANUALS

- A. Furnish complete sets of Operation and Maintenance Manuals and other information necessary for the operation and maintenance of the system in accordance with Division 1 requirements. Provide number of sets as required in Division 1, however if not specified, provide a minimum of two complete sets.

#### 1.8 WARRANTY AND SERVICE

- A. Warranty service with no deductible shall be provided for all components by a trained, certified specialist of the equipment manufacturer. The specialist shall be based in a fully staffed branch office located within a reasonable distance from the job site. This requirement applies to all components of the complete system.
- B. Warrant components, parts, and assemblies against defects in materials provided under this contract, and workmanship, for a period of five (5) years or 3,000 operating hours (whichever comes first) after Final Acceptance of this work.
- C. Warranty response time shall not exceed twenty four (24) hours.

### PART 2 - PRODUCTS

#### 2.1 SEQUENCE OF OPERATION

- A. Refer to Section 26 30 04 – Automatic Transfer Switch for additional information regarding transfer switch operation.
- B. Upon failure of the normal (utility) power source, the engine shall start and the emergency ATS shall connect the emergency load to the generator within 10 seconds.
- C. After a 60 second delay the standby ATS shall connect the standby load to the generator set.
- D. Upon restoration of normal (utility) power, the generator shall delay retransfer of standby load to the normal power source for 14 minutes, and emergency load for 15 minutes.
- E. If the emergency source fails the transfer switch shall immediately retransfer to the normal source.
- F. Provide load shed provisions to shed the Standby Load to prevent generator overload.
- G. After retransfer of load to the normal power source the engine shall run for a minimum 5 minute cool-down period.

## 2.2 ENGINE

- A. The engine shall be a compression ignition engine, naturally aspirated or turbocharged and/or after cooled. It shall be a four stroke cycle, liquid cooled, direct-injection engine of either in-line or V-type. Two stroke cycle engines will not be approved and shall not be submitted.
- B. Certified engine horsepower curves shall be submitted showing the manufacturer's approval of the engine rating for generator set standby and prime power application. Special ratings or "maximum" ratings are not acceptable.
- C. The engine shall be 1800 RPM at normal operation.
- D. The engine shall be capable of satisfactory performance on commercial grades of distilled petroleum fuel oil, including No. 1 and No. 2 diesel and heating fuels.
- E. Governor: The engine speed shall be governed by an isochronous electronic governor to maintain governed speed within +0.25% of rated frequency from steady state no load to steady state full load generator output.
  - 1. The frequency regulation from no load to rated load shall be in accordance with that defined by the engine governor performance. For any addition of load up to 100% of rated load, the frequency shall recover to the steady state frequency band within 7.0 seconds.
- F. The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crankpin bearings, pistons, piston pins, timing gears, camshaft bearings, and valve rocker mechanism.
- G. Threaded spin-on type full flow lubricating oil filters, conveniently located for servicing, shall be provided. Filter housing, integral to engine lubrication system, shall be equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged.
- H. Engine jacket water or air-to-air cooled and engine manufacturer approved aftercooler or intercooler may be furnished.
- I. The engine shall be provided with one or more dry type, replaceable element, air cleaners.
- J. The engine shall be equipped with either 12 or 24 volt negative ground electric starting system of sufficient capacity to crank the engine at a speed that will allow full diesel starting of the engine.
  - 1. Lead acid batteries shall be furnished having sufficient capacity for cranking the engine for at least two complete cranking cycles (3 @ 15 second crank cycles and 3 @ 15 second rest periods) at firing speed in the ambient temperature specified. A battery rack and necessary cables and clamps shall be provided.
  - 2. A current-limiting battery charger shall be furnished to automatically recharge batteries. Charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, temperature compensated voltage regulator, 12-hr equalize timer, DC ammeter and voltmeter, and input and output fuses. AC input shall be as required or as shown on the Drawings and output shall be rated at not less than 10 amperes. Provide monitoring of the battery charger in accordance with NFPA 110 as noted elsewhere in this Section.
- K. Provide engine preheating as follows:
  - 1. An engine mounted, thermostatically controlled (via contactor) engine coolant heater shall be provided to ensure that engine block coolant temperature is maintained in the range of 120 degrees to 140 degrees F (50 degrees - 60 degrees C). The heater shall be prewired into the generator enclosure load center. Provide a lube oil pressure switch or other approved means for automatic cut-out on engine start.
  - 2. Provide a thermostatically controlled oil sump heater sized to prevent scorching of the lube oil. Provide lube oil pressure switch or other approved means for automatic cut-out upon engine start. The heater shall be prewired into the generator enclosure load center.

- L. The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when the diesel generator set, with all engine driven accessories, is delivering full rated load at specified ambient temperature and altitude limits, with specified coolant protection.
  - 1. The engine shall be equipped with an engine driven, centrifugal-type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
  - 2. Antifreeze - the engine cooling system shall be filled with a minimum concentration of 50% ethylene glycol antifreeze with corrosion inhibitors and water pump lubrication per the engine manufacturer's recommendations. Propylene glycol protection may be submitted for approval if acceptable to the equipment manufacturer.
  - 3. The engine shall be equipped with a radiator, blower fan, and close fitting venturi shroud of a type and capacity recommended by the engine manufacturer. A rigid guard shall enclose both top and sides of all moving parts between the engine and radiator.
  - 4. The radiator shall be sized to operate safely at all anticipated ambient temperatures, and shall be equipped with a duct adapter flange.
  - 5. Prototype testing shall verify that the exact engine, fan and radiator combination provided is suitable for operation in the specified ambient conditions.
- M. A suitable silencer, of the critical type shall be provided with the engine. Silencer shall slope down away from the inlet (engine exhaust) and a condensate drain valve shall be provided at the low point.
  - 1. A flexible continuous, bellows type stainless steel seamless exhaust pipe at least 24 inches long shall be furnished for the engine exhaust outlet. The pipe outlet connections shall be compatible with standard ASA-125 lb. pipe flanges.
  - 2. The exhaust silencer shall be mounted and supported inside the generator enclosure.
- N. The engine and generator shall be equipped with suitable full length sub-base for mounting the engine-generator unit, including radiator.
- O. The generator shall be equipped with seismically restrained spring type vibration isolators between the sub-base and the floor of the generator enclosure. Coordinate generator enclosure pad mounting and reinforcing requirements and installation with other applicable Divisions. Isolators shall be suitable for Seismic site requirements.
- P. Furnish a drip pan under engine. Drip pan shall extend full length and width of engine and shall have 3/4 inch minimum depth.
- Q. Engine crankcase breather shall be equipped with a filter system (Nelson Emission Absorber or equal). Filter system shall be sized to handle the full engine blowby volume at end of engine service life, with the filter at end of service interval, without exceeding backpressure limitations on the crankcase breather. The housing of the filter system shall be installed in such a manner that the filter element(s) can be changed without removing accessory equipment. The output of the filter system shall be ducted into the atmosphere side of the engine air filter in such a manner that it does not significantly hamper servicing of the air filter element(s). Oil drain line from the filter system shall be plumbed, without valves, into the engine oil sump below the minimum oil level line, at a location that does not interfere with other features.

### **2.3 ALTERNATOR**

- A. The alternator shall be a brushless, revolving field type, coupled directly to the engine flywheel through a flexible driving disc for positive alignment. The alternator shall have a 2/3 pitch coil. The generator housing shall bolt directly to the engine flywheel housing. The generator housing shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25% over speed.
- B. The alternator shall comply with NEMA standard MG1, Part 22. Insulation shall be class F or higher as recognized by NEMA. The temperature rise of all alternator components for the class insulation being furnished, and as measured by the resistance method at the voltage specified shall be in accordance with NEMA standard MG1-22.40 for prime operation. The

generator shall be fully guarded per NEMA MG1-1.25. The maximum temperature rise shall be 80°C with Class F or higher insulation.

- C. The alternator shall have a sub-transient reactance of 12% or less.
- D. Generator Excitation System: Excitation system shall be the permanent magnet "PMG" type. The PMG and associated controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for up to 10 seconds.
- E. The rotor shall be layer wound with thermo-setting epoxy between each layer plus a final coat of epoxy for moisture and abrasion resistance. Amortisseur windings shall be integral with the rotor coil support. The rotor shaft bearing shall be shielded type with provisions for easy servicing through grease pipes that extend to the exterior of the generator frame. The bearing shall be designed for a minimum B-10 bearing life of 40,000 hours.
- F. The generator shall be furnished with a load connection box such that load conductors can enter the top or bottom of the junction box.
- G. Voltage Regulation:
  - 1. The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. The system shall be immune to misoperation due to load-induced voltage waveform distortion and shall provide a pulse width modulated output to the alternator exciter.
  - 2. The voltage regulation system shall be equipped with three phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, that shall reduce output voltage in proportion to frequency below a threshold of 58 Hz.
  - 3. The voltage regulator shall include adjustments for gain, damping and frequency roll-off. Adjustments shall be broad range, and shall be made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level.
  - 4. The balanced telephone influence factor (TIF) shall not exceed 50.
  - 5. For any addition of load up to and including 100 percent of rated load, at 0.8 power factor, the voltage dip shall not exceed 25% of rated voltage. The voltage shall recover to and remain within 1% of steady state in not more than 4 seconds
- H. Maximum motor starting kVA shall be not less than 3866 kVA at 90% sustained voltage.
- I. Total harmonic distortion of the generator output voltage waveform shall not exceed 5%, when measured line-to-line or line-to-neutral, from no-load to rated load. Under these same conditions, no single harmonic shall exceed 3% of the fundamental.

## 2.4 ENGINE-GENERATOR SET CONTROL

- A. The control shall be in compliance with NFPA 110 for a Level 2, Type 10 system.
- B. The generator set shall be provided with a microprocessor based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- C. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- D. The control shall be UL508 labeled, CSA282-M1989 certified, and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std 801.2, 801.3., and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.

- E. The generator set mounted control shall include the following features and functions:
1. Three position control switch labeled RUN/OFF/AUTO.
  2. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
  3. Red "mushroom-head" push-button EMERGENCY STOP switch: Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
  4. Push-button RESET switch: The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
  5. Push-button PANEL LAMP switch: Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- F. Generator Set AC Output Metering:
1. The generator set shall be provided with a metering set with the following features and functions:
    - a. 2.5-inch, 90 degree scale analog voltmeter, ammeter, frequency meter, and kilowatt (kW) meter. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and kW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
    - b. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.
- G. Generator Set Alarm and Status Message Display:
1. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:
    - a. low oil pressure (alarm).
    - b. low oil pressure (shutdown).
    - c. oil pressure sender failure (alarm).
    - d. low coolant temperature (alarm).
    - e. high coolant temperature (alarm).
    - f. high coolant temperature (shutdown).
    - g. engine temperature sender failure (alarm).
    - h. low coolant level (alarm or shutdown - selectable).
    - i. fail to crank (shutdown).
    - j. overcrank (shutdown).
    - k. overspeed (shutdown).
    - l. low DC voltage (alarm).
    - m. high DC voltage (alarm).
    - n. weak battery (alarm).
    - o. low fuel - daytank (alarm).
    - p. high AC voltage (shutdown).
    - q. low AC voltage (shutdown).
    - r. under frequency (shutdown).
    - s. over current (warning).
    - t. over current (shutdown.)

- u. short circuit (shutdown).
  - v. over load (alarm).
  - w. emergency stop (shutdown).
2. In addition, provisions shall be made for indication of two customer specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- H. Engine Status Monitoring:
- 1. The following information shall be available from a digital status panel on the generator set control :
    - a. engine oil pressure (psi or kPA).
    - b. engine coolant temperature (degrees F or C; Both left and right bank temperature shall be indicated on V-block engines).
    - c. engine oil temperature (degrees F or C).
    - d. engine speed (rpm).
    - e. number of hours of operation (hours).
    - f. number of start attempts.
    - g. battery voltage (DC volts).
  - 2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
- I. Control Functions:
- 1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
  - 2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
  - 3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
  - 4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
  - 5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
- J. Battery Monitoring:
- 1. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25 VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
- K. Control Interfaces for Remote Monitoring:
- 1. Control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:

- a. Form "C" dry common alarm contact set rated 2A @ 30 VDC to indicate existence of any alarm or shutdown condition on the generator set.
- b. One set of contacts rated 2A @ 30 VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
- c. A fused 10 amp switched 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
- d. A fused 20 amp 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
- e. Contacts shall be provided for monitoring by the Building Automation Control System (BAS). Contacts noted above may be used for this purpose. The following conditions shall be monitored:
  - 1). Normal power available.
  - 2). Emergency power available.
  - 3). Any alarm or shutdown condition.

## 2.5 ACCESSORIES

- A. Alarm and Status Annunciator System:
  1. A remote mounted annunciator panel (location shown on building plans) shall be provided to give visual and audible indication of impending alarm conditions, engine failure conditions and monitor certain operational functions. It shall conform with the requirements of the National Electrical Code, Section 700 and the National Fire Protection Association publications NFPA 99 and 110.
- B. Main Line Molded Case Switch:
  1. A main line molded case 3-pole switch sized per drawings shall be provided. Switch shall operate manually as an isolation switch.
  2. Overcurrent and short circuit protection shall be provided by the Onan AmpSentry protection system.
    - a. Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.
    - b. Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds.
    - c. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded .
    - d. An AC over/under voltage monitoring system which responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
  3. Molded case switch shall have auxiliary contacts for position indication to be annunciated at generator and remote panel.

## 2.6 COOLING

- A. The engine shall be radiator and fan cooled. The system shall be capable of cooling the engine under full rated load.

## 2.7 FUEL SYSTEM

- A. Engine shall have integrally mounted UL Listed double wall fuel day tank located within the skid base of the generator as noted below under Sound Attenuated Housing. Fuel inlet shall be provided with electric fuel solenoid valve on fuel supply line to prevent loss of prime from fuel storage tank.
- B. The packaged day tank shall include the following standard equipment:
  - 1. Welded flange pipe and normal/emergency vent taps sized in accordance with UL listing.
  - 2. Emergency vent caps.
  - 3. Normal vent cap.
  - 4. 2-inch manual fill connection with locking fuel fill cap.
  - 5. Supply and overfill return pump taps.
  - 6. Generator engine fuel supply and return taps.
  - 7. Tank level sensor tap.
- C. Fuel oil transfer package:
  - 1. Supply Pump: 2 GPM hydraulic gear pump (1/3 HP, 120 VAC).
  - 2. Overfill Return Pump: 2 GPM hydraulic gear over-fill return pump (1/3 HP, 120 VAC).
  - 3. Fuel strainer (100 mesh screen).
  - 4. Supply pump intake solenoid and pressure relief valves.
  - 5. Overfill return pump discharge check valve.
- D. Day tank controller:
  - 1. The day tank controller shall function to maintain fuel oil level within the day tank by controlling supply pump and overfill return pump operation. The controller also provides LED alarms for high fuel, low fuel, critical low fuel and fuel in rupture basin.
  - 2. Manual control switch (ON, OFF and TEST positions).
  - 3. Signals for pump on/off control, high and low fuel level warnings, fuel in rupture basin warning and critical low fuel warning.
  - 4. Supply and overfill return pump control.
  - 5. NEMA 4X enclosure.
  - 6. High level, low level, pump start and pump stop level switch with Buna-N floats (Model 1099).
  - 7. The controller shall be a complete UL listed 508/508a (as applicable) package. Submit shop drawings for review.
  - 8. Mfr: Global Power Components Series 400 electronic control module (ECM).
- E. Generator Connections:
  - 1. Provide steel braid reinforced flexible fuel supply and return lines to connect the engine with the sub-base tank in accordance with the engine manufacturers written installation instructions.
  - 2. Provide replaceable element fuel filter and fuel/water separator conveniently located for servicing.
  - 3. Provide diesel fuel oil supply and overfill return piping between the generator day tank and above ground fuel oil storage tank (AST-1) in accordance with Section 23 11 13 – Fuel Oil Transfer Piping.

## 2.8 SOUND ATTENUATED HOUSING

- A. The generator set shall be provided with an outdoor enclosure. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank shall be designed to be lifted into place using spreader bars. The sound attenuated housing shall be an "Onan Quiet Site Level 2" with sub-base fuel tank.
  - 1. Enclosure shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The enclosure shall have hinged access doors as required to maintain easy access for all operating and service functions. Doors shall be lockable,

- and include retainers to hold the door open during service. Enclosure roof shall be designed to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. Electrical power and control interconnections shall be made within the perimeter of the enclosure.
2. Equipment shall be enclosed with corrosion protected materials. Sheet metal shall be primed for corrosion protection and finish painted with manufacturer's standard color using a powder coat paint process. Surfaces of metal parts shall be primed and painted.
  3. Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.
  4. A factory-mounted exhaust silencer shall be installed inside the enclosure, and insulated as required to allow generator set to operate at rated load in the maximum specified ambient temperature. Exhaust connections to the generator set shall be through seamless flexible connections.
  5. The enclosure shall include the following maintenance provisions:
    - a. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
    - b. External radiator fill provision.
  6. Provide motorized louvers to minimize air flow through the enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation.
  7. Inlet ducts shall include rain hoods.
  8. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 74 dBA at any location 7 meters from the generator set in a free field environment. Insulation in the enclosure shall be made with non-hygroscopic materials.
  9. The unit shall have the following additional features:
    - a. Double wall, UL Listed, NFPA 37 compliant, 660 gallon sub-base fuel day tank.
    - b. Battery blanket heater.
    - c. Alternator heater.
    - d.
  10. Provide a factory mounted and wired electrical distribution panel to serve the generator set and enclosure. The provisions required include:
    - a. 150 Amp, 208/120V, single phase shore power load center. Factory wired normal AC service from the panelboard to generator components requiring AC power (coolant heater, oil sump heater, battery charger, battery blanket heater, alternator heater, fuel pumps, controls, lights, receptacles, etc.). the engine coolant and alternator heaters, and battery charger.
    - b. Two duplex GFCI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
    - c. Two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures.

### **PART 3 - EXECUTION**

#### **3.1 FACTORY TESTS**

- A. Equipment supplied shall be fully tested at the factory for function and performance. Provide four (4) hour factory test, consisting of one hour at each of 1/4, 1/2, 3/4, and full load. Submit test results prior to on-site test. Verify proper functionality. Record all tests including voltage and frequency dip responses and steady state values. Include test results in O&M Manuals.

#### **3.2 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### 3.3 INSTALLATION

- A. Engine-generator set shall be factory assembled, dynamically balanced and full load tested with specified coolant protection as a complete system prior to shipment as a complete assembly from the factory. Submit copy of factory test report, for testing further specified herein.
- B. Installation of engine-generator into housing assembly shall be performed by the factory or a factory-authorized dealer. Mount engine-generator on vibration isolators in accordance with manufacturer's requirements and Section 26 05 29 - Hangers and Supports and Section 13 48 00 - Vibration and Seismic Control.
- C. Mount module on pad securely to prevent movement. Comply with Seismic requirements.
- D. Seismic anchorage shall be adequate for IBC Seismic Requirements and in accordance with Section 26 05 29 - Hangers and Supports and Section 13 48 00 - Vibration and Seismic Control.
- E. Connect fuel oil supply and overfill return pump piping to above ground fuel tank system in accordance with Division 23. Provide pipe unions at each pipe connection.
- F. Mount remote annunciator as shown on Drawings.
- G. Provide a separate dedicated conduit for the engine start conductors from each transfer switch to the generator set.
- H. Mount batteries adjacent to engine within enclosure. Make connections to starter and battery charger.
- I. Emergency system wiring shall comply with NEC Article 700. Standby system wiring shall comply with NEC Article 702.
- J. Install equipment in accordance with final Submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- K. Installation of equipment shall include furnishing and installing interconnecting wiring between major equipment provided for the on-site power system. The Contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- L. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- M. Equipment shall be initially started and operated by representatives of the manufacturer.
- N. Equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

### 3.4 ON SITE ACCEPTANCE TEST

- A. Fill day tank. Furnish all consumable products for testing. At end of test refill day tank.
- B. The complete installation shall be tested for compliance with the specification following completion of site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
- D. Load tests shall demonstrate all modes of load shed control.

- E. In addition, simulate power failure at each automatic transfer switch with load transfer. Demonstrate all automatic features as directed by the Contracting Agency. Record voltage, current, and frequency during each test. Note any required adjustments. Furnish record of tests to the Department.
- F. Furnish maintenance records for Department's use.
  - 1. Manufacturers recommended periodic unit tests.
  - 2. Starting battery inspection/maintenance.
  - 3. System coolant, lubricant and other fluid inspection and replacement.
  - 4. Routine replacement parts such as filters.
  - 5. All other required maintenance to comply with NFPA 110, preserve the warranty and ensure long, reliable operation of the equipment.

### **3.5 REMOTE SYSTEM MONITORING**

- A. Provide hardwired connections to the BAS specified in Divisions 21, 22 and 23 to indicate normal power available, emergency power available and alarm conditions. Refer to Divisions 21, 22 and 23 for additional requirements.
- B. Provide remote monitoring functions required by NFPA 110, including annunciator and associated wiring and conduit systems.

### **3.6 PIPING CONNECTIONS**

- A. Diesel fuel supply to the generator from Above Ground Storage Tank specified under Division 23.

### **3.7 TRAINING**

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than two (2) separate sessions of four (4) hours in duration and the class size will be approximately 5 persons. Training dates shall be coordinated with and acceptable to the Contracting Agency.
- B. Furnish maintenance records for Department's use.

**END OF SECTION 26 30 00**

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**SECTION 26 30 04**  
**AUTOMATIC TRANSFER SWITCHES (ATS)**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section Includes:
  - 1. This section describes the scope of work for the Automatic Transfer Switches (ATS) on the Project.
- B. Related Sections:
  - 1. 01 91 00 – Commissioning
  - 2. 26 00 00 - Electrical General Requirements
  - 3. 26 30 00 - Emergency/Standby Generation System

**1.2 REFERENCES**

- A. UL 1008 Transfer Switch Equipment
- B. NFPA 110
- C. NEMA Standard ICS2-447-AC Transfer Switches
- D. NFPA 70 – National Electrical Code
- E. International Building Code (IBC) Seismic Certification

**1.3 SCOPE**

- A. The automatic transfer switch system shall include, but not be limited to transfer switches, conduit, wire, fittings and accessories required to provide a complete operating system. Units shall be located in accordance with the plans.
- B. The system shall comply with the applicable requirements of NFPA 110 - Emergency and Standby Power Systems.
- C. Provide Automatic Transfer Switches with number of poles, amperage, voltage and withstand current ratings as shown on the Drawings.
- D. Provide housekeeping pad for each floor mounted ATS as shown on the Drawings or as required.

**1.4 QUALITY CONTROL**

- A. The automatic transfer switch(es) shall be of the latest approved design as manufactured by a nationally recognized manufacturer and shall be listed by Underwriters' Laboratory and bear the UL label.

**1.5 SUBMITTALS**

- A. Provide Submittals for products in accordance with Section 26 00 00 and Division 1.
- B. Provide submittal data with the following information:
  - 1. Manufacturer's product literature and performance data, sufficient to verify compliance with specification requirements.
  - 2. Drawings and/or literature describing transfer switch equipment and other auxiliary equipment to be provided.
  - 3. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
  - 4. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
- C. Clearly mark out superfluous information.

- D. For floor mounted ATS, provide shop drawings for ATS(s) house-keeping pad(s) stamped by an Alaska licensed structural engineer. Stamped shop drawings shall indicate pad is designed to hold intended load and meet seismic requirements.

## 1.6 DEPARTMENTS MANUALS

- A. Furnish complete sets of Operation and Maintenance Manuals and other information necessary for the operation and maintenance of the system in accordance with Section 26 00 00 and Division 1 requirements. Provide number of sets as required in Division 1, however if not specified, provide a minimum of two complete sets.

## 1.7 WARRANTY AND SERVICE

- A. Warranty service with no deductible shall be provided for all components by a trained, certified specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within a reasonable distance from the job site. This requirement applies to all components of the complete system.
- B. Warrant all components, parts, and assemblies against defects in materials provided under this contract, and workmanship, for a period of one (1) years after Final Acceptance of this work.
- C. Warranty response time shall not exceed twenty four (24) hours.

## PART 2 - PRODUCTS

### 2.1 BASIS OF DESIGN

- A. Equipment specifications for this project are based on transfer switches manufactured by ASCO (7000 Series). Equipment by Cummins Power Generation or other manufacturers that meets the requirements of this Specification are acceptable provided sufficient documentation is submitted to verify compliance with specification requirements. Proposals shall include a line by line compliance statement based on this Specification.

### 2.2 AUTOMATIC TRANSFER SWITCH GENERAL REQUIREMENTS

- A. Provide complete factory assembled power transfer equipment with digital electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, positive mechanical and electrical interlocking, and mechanically held contacts.
  - 1. "ATS-E": Emergency transfer switch shall energize NFPA 101 Life Safety Systems via the building NEC Article 700 Emergency Systems Wiring.
  - 2. "ATS-MDP": Standby transfer switch shall energize standby loads via the building NEC Article 702 Optional Standby System.
- B. Ratings:
  - 1. Refer to the Drawings for the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings.
  - 2. Main contacts shall be rated for 600 Volts AC minimum.
  - 3. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
  - 4. Transfer switch equipment shall have a withstand current rating (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the Drawings.
    - a. The transfer switch shall be listed for use with "any breaker" or alternatively third party listed and labeled for use with the specific protective device(s) installed in the application.
    - b. The transfer switch shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1-1/2 and 3 cycle, long time ratings.

- C. Construction:
1. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single-solenoid mechanism, momentarily energized.
  2. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
  3. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be disconnected and serviced without disconnecting power from the transfer switch mechanism.
  4. Four pole transfer switches shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar.
- D. Connections:
1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
  2. Transfer switch shall be provided with AL/CU mechanical lugs sized to the full rating of the transfer switch.
- E. Factory Testing. The transfer switch supplier shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be available on request. Test process shall include calibration of voltage sensors.

### 2.3 TRANSFER SWITCH CONTROL

- A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
1. The control module shall direct the operation of the transfer switch. It shall be completely enclosed with a protective cover and be mounted separately from the transfer switch unit. The control module shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance. The module's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent digital communications capability.
  2. The transfer switch unit and the control module shall be mounted in the same enclosure.
  3. Operation: Settings described below shall be fully field adjustable without the use of tools, meters, or power supplies:
    - a. Provide a momentary type test switch to simulate a normal source failure.
    - b. Controller Display and Keypad.
      - 1). A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port.
    - c. The following parameters shall be adjustable via DIP switches on the controller:
      - 1). Nominal line voltage and frequency.
      - 2). Single or three phase sensing.
      - 3). Operating parameter protection.
      - 4). Transfer operating mode.
    - d. Instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.
    - e. Voltage, Frequency and Phase Rotation Sensing:
      - 1). Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and

trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Sources	Dropout / trip	Pickup / Reset
Under voltage	N&E, 3Φ	70 to 98%	85 to 100%
Overvoltage	N&E, 3Φ	102 to 115%	Same as dropout
Under frequency	N&E	85 to 98%	90 to 100%
Over frequency	N&E	102 to 110%	Same as dropout
Voltage unbalance	N&E	5 to 20%	1% below dropout

- f. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- g. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- h. Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.
- i. System Status: The controller LCD display shall include a "System" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position.
- j. Self Diagnostics The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- k. Communications Interface The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 feet) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.
- l. Data Logging: The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss.
- m. Programmed neutral position: 0.1-5 seconds. Alternatively, provide in-phase monitor or sync-check relay to prevent out-of-phase transfer (operates in either direction of transfer).
- n. Provide a circuit to cause the switch to transfer to emergency, even if normal is available, upon opening of a remote contact or toggle.
- o. Provide a selective load disconnect control circuit with time delay prior to load transfer and retransfer.

#### 2.4 CONTROL INTERFACE:

- A. The transfer switch shall provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set. Generator start signals shall be hardwired from each transfer switch back to the generator controls in the generator room.

#### 2.5 ACCESSORIES

- A. The following accessories shall be provided as a minimum (in addition to those normally required for proper operation):
  1. Auxiliary Contacts:

- a. Four sets of Form C auxiliary contacts (closed in normal position) and one set of auxiliary contacts (closed in emergency position) for remote indication of transfer switch position.
  - b. Provide terminals for remote contacts that open to inhibit transfer to emergency and/or retransfer to normal.
  - c. Provide one set of auxiliary contacts rated 10 amps, 480V AC, consisting of one contact closed when the ATS is connected to normal source and one contact dosed when the ATS is connected to emergency source. Also, one set of signal lights to indicate when the ATS is connected to normal source and when the ATS is connected to emergency source shall be provided.
2. Generator Condition Controls:
    - a. Provide a voltage and frequency sensitive lockout relay that monitors and prevents transfer until the voltage and frequency of the generator have reached the pre-set rating. Initially set to 95%.
  3. Load Shed Relays:
    - a. Provide relays in standby (Article 702 Optional Load) transfer switch to prevent automatic transfer until a signal is received. These relays shall also initiate required load shedding of the transfer switch.
  4. Elevator and Variable Speed Drive Signal Contacts:
    - a. In standby Automatic Transfer Switch, provide two time delay contacts that open (adjustable from 1-120 seconds) before transfer in either direction and reset after transfer.
  5. Communications Module:
    - a. Each ATS shall be equipped with a connectivity module. Module shall have a standard 10baseT (RJ-45) connector for connection to Ethernet TCP/IP networks. Module shall include a web page with data on transfer switch position, programmed pick-up and drop-out settings, active time delays and voltage and frequency of both sources. The associated web page shall be compatible with standard web browsers.
  6. Exercising Timer:
    - a. Provide an engine generator exercising timer built into the ATS control module that includes a selector switch to select exercise with or without load transfer. The exerciser shall be programmable to enable exercise for 1 minute to 24 hours per day in 1 minute increments for 0 to 7 days per week. The exercising timer shall be ASCO accessory 11G.
  7. Provide additional accessories as required to achieve the required operations.

## **2.6 ENCLOSURE**

- A. Transfer switches shall be mounted in NEMA 1 enclosures unless otherwise designated on the Drawings.
- B. The cabinet door shall be key lockable.

## **2.7 NAMEPLATES**

- A. Provide engraved nameplates in accordance with Specification Section 26 00 00.

## **PART 3 - EXECUTION**

### **3.1 FACTORY TESTS**

- A. Transfer equipment factory tests: Each transfer switch supplied shall be factory tested before shipment. Factory tests shall include a complete functional test of the transfer switch controls, including calibration of the voltage sensors.

### 3.2 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### 3.3 HOUSEKEEPING PAD

- A. For floor mounted transfer switches, provide concrete housekeeping pad minimum 3 inches high with minimum 2 inch reveal on front and sides for mounting transfer switch.
- B. Pads shall be capable of withstanding the complete installed load intended for the pad without damage to the pad. Refer to submittal requirements in Part 1 of this specification.
- C. Bolt transfer switch to floor with anchors complying with seismic design criteria.

### 3.4 INSTALLATION

- A. Install equipment in accordance with final Submittals and Contract Documents. Installation shall comply with applicable state and local codes as required by the Authority Having Jurisdiction. Install equipment in accordance with manufacturer's instructions.
- B. Installation of equipment shall include furnishing and installing interconnecting wiring between equipment provided for the on-site power system.
- C. Emergency system wiring shall comply with NEC Article 700.
- D. Standby system wiring shall comply with NEC Article 702.
- E. Equipment shall be installed in accordance with the seismic requirements of the site.
- F. Install required engine starting signal circuitry from switches to generator. Engine start signal shall be transmitted automatically upon loss of normal source voltage. Provide a separate dedicated conduit for the engine start conductors from each transfer switch to the generator set. Minimum size 1 inch. Provide a minimum of 4 spare wires in each conduit.
- G. Coordinate with DEPARTMENT for desired load shed sequence. Submit hierarchy to DEPARTMENTS Representative for review prior to programming.

### 3.5 SEQUENCE OF OPERATION

- A. Upon failure of the normal (utility) power source, the engine shall start and the emergency ATS shall connect the emergency load to the generator within 10 seconds.
- B. After adjustable delay the standby ATS shall connect the standby/optional load to the generator set.
- C. Upon restoration of normal (utility) power, the generator shall retransfer standby and emergency loads to the normal power source after expiration of the "retransfer to normal" time delays for each load type.
- D. If the emergency source fails the transfer switch shall immediately retransfer to the normal source.
- E. Provide load shed provisions to shed the standby load to prevent generator overload.
- F. After retransfer of load to the normal power source the engine shall run for the specified cool-down period.
- G. Field coordinate time delay settings with the Contracting Agency.

**3.6 TIME DELAYS**

A. The following time delays shall be available and set according to the following table

Name	Description	Range	Set at
Normal Failure	Delays engine starting signal to override momentary normal source outages	0-6 seconds	1 seconds
Normal to Emergency Transfer	Delays transfer to emergency source	0-60 minutes	0 seconds (ATS-E) 60 seconds (ATS-MDP)
Alternate source stabilization	Delays transfer to alternate source to ignore momentary transients during initial generator set loading	0-6 seconds	0 seconds
Retransfer to normal	Delays retransfer to normal (two conditions) 1 - Power failure mode; 2 - Test mode	0-60 minutes	Power Failure Mode - 15 minutes as noted in 3.5.C Test Mode - 0 minutes
Programmed Neutral	Delay for switch in the neutral position (e.g. not connected to normal or alternate source)	0-5 min 59 seconds	0 seconds (ATS-E) 2 seconds (ATS-MDP)
Unloaded running	Allows generator to run unloaded for engine cool down	0-60 minutes	5 minutes
Pre and post transfer signal	Delay for selective load disconnect with a programmable bypass on source failures	0-5 minutes	Field Coordinate

**3.7 LOAD DISCONNECT CONTROL INTERLOCKS**

A. Provide connections to the elevator control systems for elevators supported by the generator system to provide time delay interlock signal prior to transfer in either direction.

**3.8 ON SITE ACCEPTANCE TEST**

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Coordinate test with the Department and the Contracting Agency at least 3 working days prior to the test.

B. Provide testing of transfer switch system coordinated with generator set(s) to ensure proper operation of transfer devices under actual operating conditions. Monitor and verify correct operation and timing of the following applicable items:

1. Normal voltage sensing relays.
2. Emergency voltage sensing relays.
3. Test switches.
4. In-phase monitor or time-delay neutral.
5. Engine start sequence.
6. Time delay upon transfer.
7. Interlocks and limit switch function.
8. Load shed control.
9. Timing delay and re-transfer upon normal power restoration.

- 10. Engine cool-down time delay and shut down.
- C. Furnish record of tests to the Department.

**3.9 TRAINING**

- A. Provide a minimum of one week written notification to Department of the training schedule. Training dates shall be coordinated with and acceptable to the Contracting Agency.
- B. Provide Operation and Maintenance manual information to the Department prior to scheduling the instruction session.
- C. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than (2) hours in duration.
- D. The session shall be conducted by the Contractor's Representative thoroughly familiar with the characteristics of the system.

**END OF SECTION 26 30 04**

**SECTION 26 33 53**  
**STATIC UNINTERRUPTIBLE POWER SUPPLY**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This specification describes a three phase continuous duty, on-line, solid state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the building electrical system to provide power conditioning, backup and distribution for critical electrical loads. The system shall consist of the UPS module; valve regulated lead acid (VRLA) battery packs, and other features as described in this specification.

**1.2 REFERENCES**

- A. General: The publications listed below form a part of this specification. The referenced publications shall be the latest edition and revision as of the date of the Contract Documents.
- B. UL1778-(Underwriters Laboratories) Standard for Uninterruptible Power Supply Equipment. Listed Equipment (US and Canada).
- C. UL 60950-1 (Underwriters Laboratories) Standard for Information Technology Equipment
- D. CSA C22.2 NO.107.1-M91 - (Canadian Standards Association) Commercial and Industrial Power Supplies. Listed Equipment (US and Canada).
- E. NEMA PE-1-1983- (National Electrical Manufactures Association) Uninterruptible power systems standard.
- F. IEC 62040-2 - (International Electrotechnical Commission) Electromagnetic Compatibility Requirements of Uninterruptible power systems
- G. IEC 62040-3 - (International Electrotechnical Commission) Methods of specifying performance and test requirements of Uninterruptible power systems.
- H. FCC Rules and Regulations 47, Part 15, Subpart J, Class A (Federal Communications Commission) Certified compliance.

**1.3 SYSTEM DESCRIPTION**

- A. Design Requirements:
1. The UPS shall be sized for 100KVA load.
  2. The UPS battery shall be sized for 15 minutes of runtime at full load.
- B. UPS Input:
1. AC input Nominal Voltage: 208Y/120V three-phase, 4 wires plus ground, 60HZ
  2. AC input Voltage Window: +/-15%
  3. Short Circuit Withstand Rating: As noted on the Drawings
  4. Input Frequency Window: +/-15%
- C. UPS Output:
1. AC Output Nominal Voltage: 208Y/120V three-phase, 4 wires plus ground, 60HZ
  2. AC Output Regulation: +/- 1%
  3. Voltage Transient Response: +/- 5%
  4. Voltage transient Recovery: Within 50 milliseconds
  5. Over Load Capabilities:
    - a. Normal Operation: 150% for 30 seconds before transfer to bypass.
    - b. Battery Operation: 150% for 30 seconds.
    - c. Bypass Operation 125% continuous at 208V.

#### 1.4 SUBMITTALS

1. Operation Manual: An operation manual shall be furnished and shall describe the UPS in full by including the following major items:
  - a. Operating Procedures.
  - b. Performance Data and Technical Data.
  - c. General Description.
  - d. UPS module Description.
  - e. Communications Capability.
  - f. Battery Description.
  - g. Accessory Description.
  - h. Spare parts kit description and itemization.
2. Installation Manual: An installation manual shall be furnished. It shall possess sufficient detail and clarity to enable the Department's technicians to install the system equipment. The following drawing and data sheets shall be supplied:
  - 1). Receiving and Installation Instructions.
  - 2). System One-Line Drawings.
  - 3). Equipment Outline Drawings.
  - 4). Interconnection Drawings.
  - 5). Battery Wiring Diagram.
  - 6). Accessory Wiring Diagrams.

#### 1.5 QUALIFICATIONS

- A. The UPS manufacturer shall have a minimum of ten years experience in the design, manufacture and testing of solid-state, UPS systems.
- B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and the field service organization.
- C. The installer shall be a firm that has a minimum of five years of successful installation experience with UPS projects similar in type and scope to that of this project.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

- A. The system shall withstand any combination of the following external environmental conditions without operational degradation.
  1. Operating Temperature: 0 degrees C to +40 degrees C without derating.
  2. Relative Humidity (operating and storage): 0 to 95% maximum non-condensing.
- B. Acoustical Noise: Noise generated by the UPS under normal operation shall not exceed 67 dBA at one meter from any operator surface.
- C. EMI Suppression: The UPS shall meet FCC Rules and Regulation, 47, Part 15, Subpart J, for Class A devices.
- D. Electrostatic Discharge (ESD): The UPS shall meet IEC 801-2. The UPS shall withstand up to 25 kV without damage and with no disturbance or adverse effect to the critical load.
- E. Efficiency: The typical system efficiency shall be no less than 92% at full unity power factor load and nominal input voltage.
- F. Input Surge Withstand Capability: The UPS shall be in compliance with ANSI C62.41, Category A & B (6 kV).

#### 1.7 WARRANTY

- A. System: The system warranty shall extend a minimum of 24 months after final acceptance and shall include all costs including repair, parts, labor, travel and living expenses for the manufacturer's service personnel.

- B. Battery: The UPS manufacturer shall warrant the battery on a prorated basis for ten years to deliver no less than 80% of its rated capacity, provided the prevailing ambient temperature of the battery area does not exceed 25 degrees C (77 degrees F).

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. The Basis of Design is APC Symmetra PX, manufactured by APC, to set a standard for quality. Equivalent products by other manufactures will be considered providing that sufficient documentation is provided to satisfy the Department that the equipment meets the requirements of the Specifications, and matches the Basis of Design on all points which are pertinent to the Project.

### **2.2 MODES OF OPERATION**

- A. Normal: The Input converter and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
- B. Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.
- C. Recharge: Upon restoration of utility power to the UPS input, the input converter and output inverter shall simultaneously recharge the battery and provide regulated power to the critical load.
- D. Static Bypass: The static bypass shall be used to provide controller transfer of critical load from the inverter output to the bypass source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of an emergency, this transfer shall be an automatic function.
- E. Maintenance Bypass: The system shall be equipped with an external make-before-break maintenance bypass cabinet (MBC) to electrically isolate the UPS during routine maintenance and service of the UPS. The MBC shall allow for the complete electrical isolation of the UPS. A positive electrical signal from the UPS shall be required to indicate when the UPS is in bypass mode before any manual or automatic transfer to the maintenance bypass source can be initiated. The Maintenance Bypass Panel shall be manufactured by the same manufacturer as the UPS.

### **2.3 INPUT CONVERTER**

- A. General: The Input converters of the system shall be housed within the removable power modules, and shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and main inverter regulated output power. These power modules shall be connected in parallel within the UPS frame.
- B. Input Current Total Harmonic Distortion: The input current THDI shall be held to less than 5 percent at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting both a linear or non-linear load. This shall be accomplished without the requirement for additional filters, magnetic devices, or other components.
- C. Soft-Start Operation: As a standard feature, the UPS shall contain a user-adjustable soft-start, capable of limiting the input current from 0 percent to 100 percent of the nominal input over a default 10 second period, when returning to the AC utility source from battery operation. The

change in current over the change in time shall take place in a linear manner throughout the entire operation.

- D. Magnetization Inrush Current: The UPS shall exhibit zero inrush current as a standard product. If provided with an optional isolation transformer, inrush shall be limited to 11 times the nominal input current of the transformer.
- E. Input Current Limit:
  - 1. The Input converter shall control and limit the input current draw from utility to 150 percent of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100 percent load, charge batteries at 10 percent of the UPS output rating, and provide voltage regulation with mains deviation +15/-5 percent.
  - 2. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100 percent of UPS capacity, input current shall not exceed 125 percent of UPS output current, while providing full battery recharge power and importing necessary power to account for system losses.

## 2.4 MECHANICAL DESIGN

- A. Enclosures: The UPS module shall be housed in free standing, double front enclosures (safety shields behind doors) equipped with casters and leveling feet. The enclosures shall be designed for industrial or computer room applications in accordance with the environmental requirements. The enclosures shall line up and match up in style and color for an aesthetically pleasing appearance. Each of the enclosures shall be shipped separately with joining hardware to be bolted together at the time of installation.
- B. Ventilation: The UPS module shall be designed for forced air cooling. Air inlets shall be in the lower front. Air outlets shall be in the rear of the top.
- C. Cooling Fans: The modular design of the UPS module shall permit removal of each fan without removal of any other assembly. Fan replacement shall not require the removal of another subassembly.
- D. Cable Entry: Standard cable entry for the UPS module shall be through either the enclosure bottom or top. A dedicated wireway shall be provided within the UPS module for routing user input and output wiring.
- E. Front Access: Serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). All components with exception of the power magnetic shall be located within the front 12 inches of the UPS enclosure for easy maintenance access. Removal and replacement of subassemblies shall not require the removal of another subassembly.
- F. Service Area Requirements: The UPS module, battery and options enclosures shall require no more than thirty (30) inches of front service access room, and shall not require side access for service or installation.

## 2.5 BATTERY

- A. Battery Type: Valve-regulated, high-grade discharge, lead-acid cells.
- B. Expected Life: 200 complete full load discharge cycles when operated and maintained within specifications.
- C. Batteries cases shall be made from fire retardant materials.
- D. Final Discharge Voltage:
  - 1. Full Load: 1.66 V per cell (adjustable).
  - 2. No Load: 1.75 V per cell (adjustable). The UPS shall automatically select the final discharge voltage (either 1.66 or 1.75 Volts per cell) based on the rate of discharge.
- E. Nominal Float Voltage: 2.25 V per cell.

- F. Maximum Equalizing Voltage: 2.40 V per cell.
- G. Battery Capacity Protection Time (at 25 degrees C): 30 minutes at full rated load.
- H. Battery Recharge Time: 10 times the discharge time to 95% of the original protection time.

## 2.6 CONTROLS AND INDICATORS

- A. Micro-Controller Operated Circuitry: The UPS controls shall have the following design and operating characteristics:
  - 1. Fully automatic operation of each UPS module shall be provided through the use of micro-controllers. (Digital signal processing shall eliminate variances from component tolerance or drift, and provide consistent operational responses.)
  - 2. Operating and protection parameters shall be firmware controlled, eliminating the need for manual adjustments. Adjustments and calibrations shall be performed without the use of potentiometers. Printed circuit boards replacement shall be possible without requiring calibration.
  - 3. Start-up and transfers shall be automatic functions.
  - 4. Multiple micro-controllers shall be used, so no single controller is in a mission critical application.
  - 5. Configuration, setup and calibration information shall be stored in non-volatile memory that does not require a control battery for data storage.
  - 6. Emergency transfers to Bypass due to UPS failure, shall be independent of the control logic controlling the Rectifier/Charger, Inverter and Monitor panel. Emergency transfer circuitry shall contain the necessary circuitry to perform an emergency transfer without other functioning logic.
  - 7. Monitoring and communications logic shall be independent of the Input Converter and Inverter control logic. Circuitry and firmware required for monitoring and communications logic shall be functionally isolated from the bypass. Rectifier/Charges and Inverter controls. Monitoring firmware shall be field upgradeable.
  - 8. The UPS shall be programmable to optionally provide automatic restart capability following loss of utility and a complete battery discharge. When utility power returns, the UPS shall automatically energize the output terminals and subsequently transfer to Normal mode.
- B. Monitor Panel Indicators: The UPS module shall be equipped with a monitor panel providing the following monitoring functions and indicators (each alarm and notice condition shall be accompanied with an audible alarm):
  - 1. NORMAL: This symbol shall be lit when the UPS is operating in Normal mode.
  - 2. BATTERY: This symbol shall be lit when the UPS is operating in Battery mode. The Normal indicator also remains lit.
  - 3. BYPASS: This symbol shall be lit when the UPS is operating in Bypass mode. The critical load is supported by the Bypass source. The Normal indicator shall not be lit when the system is in Bypass mode.
  - 4. NOTICE: This symbol shall be lit when the system needs attention. Some notices may be accompanied by an audible horn. Notices shall include:
    - a. Bypass not available.
    - b. Battery under voltage.
  - 5. ALARM: This symbol shall be lit when a situation requires immediate attention. All alarms shall be accompanied by an audible alarm. Alarms shall include:
    - a. Over temperature.
    - b. Output overload.
    - c. Inverter failure.
    - d. Input Converter failure.
    - e. Shutdown imminent (Low battery in Emergency mode.)
  - 6. STANDBY: This symbol shall be lit when electricity is present in the rectifier and Inverter while the Normal indicator is not lit. During normal startup this indicator shall remain lit

until the UPS transfers to Normal mode, at which time the Normal indicator shall light. During normal shutdown the Standby indicator shall remain lit until all energy in the UPS is dissipated and shutdown is complete.

- C. Monitor Panel Controls: The UPS module shall be equipped with a monitor panel providing the following control functions:
1. Menu and Cursor Controls: Selects displays and scrolls data on the LCD.
  2. Load Off: Shuts down the UPS, de-energizes the critical load and opens the UPS's breaker and Contractors.
  3. Horn Silence: Silences the current audible alarms(s). The Horn shall sound again if new alarms occur.
  4. Screen Adjust: Controls the liquid crystal display contrast.
- D. Monitor Panel Liquid Crystal Display (LCD): The UPS shall feature a liquid crystal display measuring 6 inches by 7.5 inches with 30 lines of information, 80 characters wide. The display shall feature an auto blanking feature. Graphical user screens shall be provided on the Monitor panel LCD to display the UPS operating parameters. The monitor panel push buttons shall be used to access information in these screens. Information in the meter screen and alarm history screen shall be available to a remote terminal or printer through the RS-232 (EIA/TIA-232) communication port. The screens shall include:
1. Common Information: The following information shall be presented on the LCD panel at all times:
    - a. UPS Identification: A user programmable UPS identification of up to 45 characters.
    - b. UPS status.
    - c. Highest priority active alarm.
    - d. Highest priority active notice.
    - e. Time and date.
    - f. Real-time battery time available (in the event a utility outage occurs) for the current critical load.
  2. System Meter Screen: Real-time digital metering of:
    - a. Input Converter inputs: voltage (per phase, RMS), current (per phase), frequency, kW, kVA, power factor.
    - b. System outputs: voltage (per phase, RMS), current (per phase plus neutral), frequency, kW, kVA, power factor. Output voltage and current sensing shall independent of the Inverter controls.
    - c. Bypass inputs: voltage (per Phase, RMS).
    - d. DC link voltage.
    - e. Battery charge and discharge current.
  3. Output Current Screen: Bar graph display of the percent output current of each phase.
  4. Event History Screen: Shall display up to 400 of the most recent events by date and time. Time shall be displayed in tenths of seconds (0.1 sec) and recorded in thousandths of seconds (0.001 sec). The screen shall define and display events as either alarms, notices, commands or status. A brief description shall be provided for each event recorded on this screen.
  5. Active System events Screen: Shall automatically display a list of active alarms and notices.
  6. Statistics Screen: This screen shall display the following:
    - a. Time on battery: A record shall display the duration and frequency of utility outages in the life of the batteries and in the current month.
    - b. Building alarms: A record shall display the frequency of each building alarm enunciation in the life of the UPS and in the current month.
    - c. Operational History: A record shall display the total amount of time the UPS has been in the each of the following modes of operation: Normal, Bypass and Battery. A record shall display the total amount of time the UPS has been on generator.
    - d. Availability: The observed availability of the Normal mode shall be displayed. In addition, the availability of the bypass supply as a backup source shall be displayed.

- e. Startup Date: The date the UPS was initially energized shall be displayed.
- 7. Setup Screen: Shall permit setting time and date for the system clock with controls on the Monitor Panel. Shall permit configuration of the RS232 and RS485 communication ports, with controls on the Monitor Panel, for the following modes of operation:
  - a. Terminal Mode: System events shall be logged immediately as they occur.
  - b. Calibration Mode: Shall be used by service personnel for system diagnostics.
  - c. System Configuration Mode: Shall allow setup and configuration of user level functions like battery test and building alarms. Shall allow the six building alarms to be customized with a description of up to 30 characters for display locally on the monitor panel screens and remotely. Shall allow the six building alarms to be programmed to initiate UPS commands upon contact closure.
  - d. Computer Mode: Shall allow the user to interface with the UPS in Binary Computer Mode.
  - e. Remote Monitor Mode: The RS485 port shall be configured to interface with a Remote Monitor Panel, Supervisory Contact Module or Relay Interface Module.
- E. Control Panel: The UPS module shall be equipped with a control panel providing UPS control functions. (A key shall be required to turn on the UPS.) The following controls shall be provided on the control panel:
  - 1. The Key switch shall initiate the energize sequence to place the UPS in either Normal mode or Bypass mode, as defined by the Mode switch position.
  - 2. The Mode switch shall control the manual transfer of the UPS to and from Bypass mode.
  - 3. The Battery switch shall enable or disable the internal battery Contractor closure.
  - 4. A circuit breaker shall enable operation of the rectifier.
  - 5. A load Off Reset switch shall reset the UPS, following a Load Off command.
- F. Communication Panel: The UPS module shall be equipped with a communication panel, loaded behind a protective cover, which provides the following signals and communication features in a Class 2 environment:
  - 1. Alarm and Notice Contacts: Dry contacts for summary alarms and notices shall be provided for external use.
    - a. Alarm: Indicates the UPS is experiencing an Alarm Condition.
    - b. Notices: Indicates the UPS is experiencing a Notice condition.
  - 2. RS-232 (EIA/TIA-232) and RS-485 Communication Interface; circuitry shall be provided for one RS-232 (EIA/TIA-232) and one RS-485 communication port. These ports may be used with simple terminals to gain remote access to unit operation information.
  - 3. Remote Monitor Panel Connection: Circuitry shall be provided for connection of up to two accessory remote monitor panels, relay interface modules or supervisory contact module.
  - 4. Building Alarms: Six inputs shall be provided for monitoring the status of external dry contacts. One input shall be dedicated to monitoring an external battery disconnects, and one shall be dedicated to monitoring an auxiliary generator and initiating reduced input current limit. The remaining four inputs shall be user selected (smoke, temperature, water, etc.) Building alarms shall be set up through the system configuration mode function of the RS-232 (EIA/TIA-232) port. The building alarms shall also provide the following capabilities:
    - a. Building alarms shall be programmable to initiate UPS commands upon contact closure.
    - b. Building alarms shall allow the user to customize the building alarm message (up to 30 characters maximum) which appears locally on the Monitor Panel or remotely through the communication ports.

## 2.7 SYSTEM PROTECTION

- A. Input Converter protection shall be provided by thermal magnetic or RMS current sensing molded case circuit breakers and transient suppression circuitry.
- B. Bypass protection shall be provided through individual fusing of each phase.

- C. The static switch shall feature a thermal switch which will open the back feed contactor in the event the static switch temperature exceeds normal operating parameters.
- D. Battery protection shall be provided by thermal magnetic molded case circuit breakers in each battery cabinet.
- E. Output protection shall be provided by electronic current limit circuitry and fuses in the Inverter circuit.
- F. Input wiring to the Input Converter and bypass input shall be monitored for proper sequencing. If wiring is installed out of sequence, the UPS shall detect and annunciate this condition (on the Monitor Panel) when power is supplied to the inputs. The UPS shall not allow operation in Normal mode until the wiring error is corrected.
- G. Inverter circuitry shall be provided which automatically inhibits the Inverter IGBT switching currents should they exceed normal operating parameters.
- H. The UPS shall remain in Normal mode during a failure condition where the Bypass back feed protection fails. Manual transfers between Normal mode and Bypass mode shall be possible with this failure condition.
- I. The UPS shall remain in Normal mode during a failure condition where one or more SCRs in the static switch shorts. Manual transfers between Normal mode and Bypass mode shall be possible with this failure condition.
- J. To comply with agency safety requirements, the UPS shall not rely upon disconnect devices outside of the UPS module to isolate the battery cabinet from the UPS.

## **2.8 MAINTENANCE BYPASS SWITCHBOARD**

- A. General: A manually operated two input bypass panel shall be provided by the UPS manufacturer to directly connect the critical AC input load to the AC input power source, completely bypassing the UPS module.
- B. The panel shall be rated 208V, 400A, 3 phase, 4 wire plus ground and shall include a fully rated neutral bus. The panel shall have a short circuit withstand rating of 30,000 amps.
- C. Mechanical Design: The maintenance bypass breakers shall be housed in a wall mounted, dead front, NEMA Type 1 enclosure; requiring no back or side access. The enclosure shall be provided with a hinged, lockable front cover.
- D. Breakers: The maintenance bypass panel shall include a 3 pole, 208V, bypass input non-automatic circuit breaker rated at 400 amps, 3 pole, 208V; main bypass non-automatic circuit breaker rated at 400 amps, 3 pole, 208V; main output non-automatic circuit breaker rated at 400 amps.
- E. A positive electrical signal from the UPS shall be required to indicate when the UPS is in bypass mode before any manual or automatic transfer to the maintenance bypass source can be initiated.
- F. The UPS manufacturer shall provide complete transfer instructions securely mounted to the inside cover of the maintenance bypass switchboard.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install shall be in accordance with manufacturer's instructions.
- B. Field coordinate the exact locations of the UPS and Remote Monitor Panel prior to installation.

### **3.2 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

- B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:
1. Visual Inspection:
    - a. Visually inspect all equipment for signs of damage or foreign materials.
    - b. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and other safety related factors.
  2. Mechanical Inspection:
    - a. Check the power connections for tightness.
    - b. Check input and bypasses power for proper voltages and phase rotation.
    - c. Check lamp test functions.
  3. Electrical Precheck:
    - a. Check the DC bus for a possible short circuit.
    - b. Check input and bypasses power for proper voltages and phase rotation.
  4. Initial UPS Startup:
    - a. Verify that the alarms are in a "go" condition.
    - b. Energize the system and verify the proper DC, walkup, and AC phase on.
    - c. Check the DC link holding voltage, AC output voltages, and output wave forms.
    - d. Check the final DC link voltage and Inverter AC output.
    - e. Check for the proper synchronization.
    - f. Check for the voltage difference between the Inverter output and the bypass source.
  5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation. The vendor shall provide training to enable staff to monitor and control the UPS. This training should cover both the routine day-to-day operation of the UPS and emergency operation procedures. Reporting trouble and obtaining services should also be covered. Provision should be made for training ten (10) Municipal employees.

### **3.3 MANUFACTURER'S FIELD SERVICE**

- A. Field Engineering Support: The UPS manufacturer shall directly employ an Anchorage based field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed to provide on-site emergency response within 4 hours.
- B. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.

**END OF SECTION 26 33 53**

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**SECTION 26 50 00  
LIGHTING FIXTURES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general requirements, products and methods of execution relating to Lighting Fixtures approved for use on this project.
- B. The Fixture Schedule is a general guide to type, quality and other characteristics. Fixtures of equal or better performance and quality may be substituted, subject to approval.

**1.2 RELATED SECTIONS**

- A. 01 91 00 – Commissioning
- B. 26 27 26 – Wiring Devices
- C. 26 27 49 – Network Lighting Control System
- D. 26 50 10 – Lamps and Ballasts

**1.3 QUALITY CONTROL**

- A. The fixture shall be a standard catalog item as described on the Drawings and as made by a nationally recognized manufacturer.

**1.4 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 and Division 1.
- B. Fixture mounting shall be clearly identified on submittal information and coordinated with architectural reflected ceiling plan.
- C. Fixtures and poles with color selections shall have color chips submitted for final color selection by Department.

**1.5 SHOP DRAWINGS**

- A. Provide fabrication drawings that indicate fixture, type, kind, weight, lamp, ballast, method of fitting and fastening parts together, location and number of sockets, and complete details of method of fitting suspension and fastening fixtures in place. Verify fixture dimensions with construction conditions prior to ordering fixtures.
- B. Provide wiring diagrams that indicate supply power and interconnections for lighting control equipment and light fixtures. Provide sufficient information to assemble and install equipment at the project site without further instructions.

**1.6 WARRANTY**

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Interior Lighting Fixtures: 36 months from date of Substantial Completion.
  - 2. Exterior Lighting Fixtures and poles: 60 months from date of Substantial Completion.
  - 3. Controls mounted on or integral to Lighting Fixtures: 60 months from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Provide fixtures in conformance with the Fixture Schedule, with all required flanges and supports. Lighting Fixtures shall be provided complete with all suspension, trim, mounting, and operating accessories normally considered necessary for a complete, functional, and safe installation, whether specifically called for in the Contract Documents or not.

### **2.2 LINEAR SYSTEMS**

- A. Linear fixture systems shall be provided with all corners, transitions, adjustable sections, custom angles, etc., to provide continuous linear systems. These features shall be provided to center the lamp cavity(s) of the fixtures within the designated mounting space(s) (typically wall-to-wall).

### **2.3 LIGHT EMITTING DIODE (LED) FIXTURES**

- A. LED fixtures shall comply with Illuminating Engineering Society (IES) LM-79 guidelines.
- B. Fixture shall have an LM-79 photometric test report from an NVLAP accredited laboratory.
- C. Fixture shall utilize components (i.e. LEDs, driver, fixture housing, etc) included in LM-79 test.
- D. Fixture shall have lumen maintenance testing with minimum test duration of 10,000 hours.
- E. Manufacturer stated end of life shall be at 70% light output. Operating life shall be no less than 50,000 hours.

### **2.4 RECESSED FIXTURES**

- A. Fixtures shall have thermal protection conforming to NEC and shall so be identified as thermally protected unless fixture is:
  - 1. Identified for use and installed in poured concrete, or
  - 2. Identified as suitable for installation in cavities where the thermal insulation will be in direct contact with the fixture.

### **2.5 TAMPERPROOF-TYPE FIXTURES**

- A. Furnish one tamperproof screwdriver of each type required by fixtures specified on this project.

### **2.6 ACCESSORIES**

- A. Lenses for recessed fluorescent fixtures shall be 100 percent virgin acrylic with a minimum overall thickness of 0.125", except where specifically noted.

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 INSTALLATION**

- A. Install fixtures level, plumb and true. Align rows accurately in three dimensions.
- B. Support suspended acoustical ceiling fixtures according to the requirements of the IBC and Section 26 05 29 and Section 13 48 00 as well as any local amendments.
- C. Fixture pendants, canopies, blank sections, corners, tees and other such accessories shall be finished to match their respective fixture.

- D. Refer to applicable details on architectural drawings for specific mounting requirements for all fixtures with special mounting requirements such as cove-mounted fixtures and linear fixtures.
- E. For linear fixture systems, verify fixture dimensions and mounting type with other trades prior to installation.
- F. Utility Rooms: Surface ceiling mount fixtures in rooms/areas with ceilings. In areas without ceilings pendant fixtures down to bottom of structure. In areas with mechanical equipment, ductwork and piping, pendant fixtures down to bottom of mechanical ductwork or piping as appropriate. Fixture pendants shall be rigid (threaded hangar rods) and shall be sway braced where pendants exceed 24 inches in length.
- G. Provide an un-switched circuit connection for the following:
  - 1. Exit signs
  - 2. Emergency lighting units (ELUs)
  - 3. Emergency fixtures
  - 4. Night lights
- H. Wiring for fixtures connected to emergency circuits shall be kept entirely independent of other wiring and equipment in accordance with NEC article 700.
- I. Clean all fixtures and lenses prior to final acceptance.

### **3.3 FIRE-RESISTIVE CONSTRUCTION**

- A. Refer to Section 26 05 00 Basic Materials and Methods.

### **3.4 EXTERIOR FIXTURES**

- A. Exterior fixtures, supports and pole assemblies shall be capable of withstanding 110 mph winds with gusts to 145 mph with no damage. Where the Contracting Agency or any regulatory agencies require higher values for these, the more stringent requirements shall apply.
- B. Anchor Bolts: Provide the quantity and type of anchor bolts required by the pole manufacturer. Provide flat-washers, lock-washers and hexagonal nuts. Provide template for positioning anchor bolts. All anchor bolts shall be hot dip galvanized.
- C. Poles:
  - 1. Non-anodized poles shall be factory painted with polyester powder coat. Touch up all damage to paint.
  - 2. Anodized aluminum poles shall be finished with an Aluminum Association Architectural Class 1 anodized finish.
  - 3. Refer to Specification Section 27 05 24 Digital Video Recording System for additional requirements for poles with exterior CCTV cameras.

### **3.5 FLOOD/ACCENT LIGHTING**

- A. Coordinate with Contracting Agency to field adjust aiming of all adjustable flood/accent lighting.
- B. Permanently mark mounting equipment with final aiming orientations to facilitate later re-aiming after maintenance.

**END OF SECTION 26 50 00**

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**SECTION 26 50 10  
LAMPS AND BALLASTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes general requirements, products, and methods of execution relating to lamps, ballasts and related products approved for use on this Project.

**1.2 RELATED SECTIONS**

- A. 01 91 00 - Commissioning
- B. 26 27 26 - Wiring Devices
- C. 26 27 49 - Network Lighting Control System
- D. 26 50 00 - Lighting Fixtures

**1.3 QUALITY CONTROL**

- A. Lamps specified in this Section shall be as manufactured by Osram Sylvania, Philips, General Electric or Venture.
- B. LEDs specified in this Section shall be as manufactured by Nichia, Samsung, or Cree.
- C. Ballasts specified in this Section shall be as manufactured by Osram, Advance, or Universal, unless noted otherwise.

**1.4 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00-Electrical General Requirements and Division 1.
- B. Lamps, ballasts and related products are generally included in the fixture schedule on the plans. Verify that the fixture types submitted for approval contain components complying with the product specifications of this Section.

**1.5 SHOP DRAWINGS**

- A. Provide shop drawings in accordance with Section 26 50 00 - Lighting Fixtures.

**1.6 WARRANTY**

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Lamps: 24 months from date of Substantial Completion.
  - 2. Ballasts: 60 months from date of Substantial Completion.
  - 3. LEDs/LED Drivers: 60 months from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.1 INCANDESCENT LAMPS**

- A. Incandescent lamps installed in air handling units or mechanical spaces shall be extended life (A/99) with a design voltage of 130 volts, suitable for operating between 120 and 130 volts.
- B. MR16 lamps shall have greater than 90% lumen maintenance over the life of the lamp, with minimum 18,000 hour lamp life, USHIO Ultraline Titan or as approved.

## 2.2 FLUORESCENT LAMPS

- A. Lamp type, color temperature, and color rendering index (CRI) shall conform to the lighting fixture schedule shown on the Drawings.
- B. To the extent that they are commercially available all fluorescent lamps shall be low mercury type. Low mercury lamp types shall meet the requirements for classification as non-hazardous waste when subjected to the Toxic Characteristic Leaching Procedure (TCLP) prescribed by the Environmental Protection Agency at end of life and shall be clearly identifiable from other lamp types.

## 2.3 HIGH INTENSITY DISCHARGE LAMPS

- A. Provide low mercury, lead free base type lamp that meets the requirements for classification as non-hazardous waste when subjected to the Toxic Characteristic Leaching Procedure (TCLP) prescribed by the Environmental Protection Agency.
- B. Lamp type, color temperature, and color rendering index (CRI) shall conform to the lighting fixture schedule shown on the Drawings. Metal Halide Lamps:
  - 1. Lamps for use in open fixtures shall be Type "O" rated.
  - 2. Lamps shall be coated, reduced color shift type.
  - 3. Lamps shall be high output type except where prohibited by lamp orientation.
  - 4. Pulse Start metal halide lamps shall be provided with pulse start technology, lumen maintenance greater than 80%, hot re-strike less than 4 minutes.

## 2.4 LIGHT EMITTING DIODES (LEDS)

- A. LEDs shall comply with Illuminating Engineering Society (IES) LM-80 guidelines.
- B. Manufacturer stated lamp end of life shall be at 70% light output. Lamp operating life shall be no less than 50,000 hours.

## 2.5 FLUORESCENT BALLASTS - ELECTRONIC NON-DIMMING

- A. Fluorescent dimming ballasts shall be electronic type with a power factor greater than 95% and meet applicable UL standards and be so labeled.
- B. Ballasts shall provide "programmed rapid start" lamp starting.
- C. Total harmonic distortion (THD) shall be less than 10%.
- D. Ballast factor shall be between 0.87 and 1.00.
- E. Ballasts shall be Class "P" with automatic reset.
- F. Ballasts shall be sound rated "A".
- G. Ballasts shall meet the requirements of FCC Rules and Regulations, Part 18 for RFI/EMI emissions.
- H. Ballasts shall have a frequency of operation greater than 42 kHz to avoid interference with infrared devices and eliminate visible flicker.
- I. Ballasts shall provide a lamp crest factor of 1.7 or less.
- J. Ballasts shall comply with ANSI C62.41 Category A surge protections standards.
- K. Ballasts specified in this Section shall maintain constant light output over operating ranges of 108V to 132V (120V ballasts) and 249V to 305V (277V ballasts).
- L. Linear Lamps
  - 1. Ballast shall have a minimum starting temperature of 0 degrees Fahrenheit for standard T5/T5HO lamps.
  - 2. Ballasts installed in exterior locations, unheated areas, freezers, coolers, garages or areas that at some time may approach ambient exterior temperature shall have a minimum starting temperature of -20 degrees Fahrenheit.

M. Compact Fluorescent Lamps

1. Ballast shall have a minimum starting temperature of 0 degrees Fahrenheit.
2. Ballasts shall provide end of life lamp protection.
3. Ballasts installed in exterior locations, unheated areas, freezers, coolers, garages or areas that at some time may approach ambient exterior temperature shall have a minimum starting temperature of -20 degrees Fahrenheit.

**2.6 FLUORESCENT BALLASTS – DIGITAL ADDRESSABLE DIMMING**

- A. Refer to Specification Section 26 27 49 Network Lighting Control System.

**2.7 BALLAST DISCONNECTING MEANS**

- A. In indoor locations, fluorescent luminaires that utilize double-ended lamps and contain ballast(s) shall have a disconnecting means either internal or external to each luminaire to disconnect simultaneously from the source of supply all conductors of the ballast including the grounded conductor in accordance with National Electrical Code (NEC) Article 410.

**2.8 HIGH INTENSITY DISCHARGE BALLASTS**

- A. Outdoor ballasts shall be rated for operation in normally anticipated ambient temperatures.
- B. Metal Halide ballasts:
1. The ballast shall be of the regulator type (constant wattage autotransformer, CWA).
  2. The ballast shall be high power factor (95%) and operate the lamp satisfactorily with a voltage variation of plus or minus 13%.
  3. Provide ballast with an integral igniter for pulse start Metal Halide lamps.

**2.9 LED DRIVERS**

- A. LED drivers
1. Input 120-277V, 50/60Hz (100-305V with tolerances)
  2. Efficiency: >90% at full load at nominal working voltage
  3. PF>0.9 over all input voltages
  4. Harmonic<20% overall all input voltages
- B. LED Dimming
1. Provide dimming driver and compatible dimming controls in accordance with manufacturer's specific requirements.

**PART 3 - EXECUTION**

**3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

**3.2 INSTALLATION**

- A. Ballasts shall be installed per manufacturer's recommendations.
- B. Fixtures that have integral ballasts shall have the ballast installed and prewired at the factory.
- C. Tandem wiring harnesses internal fixture wiring shall be factory assembled and installed in all pairs of fluorescent fixtures which share a common ballast. All wiring harnesses shall include an integral copper Grounding conductor and be approved for use in air plenums.

**END OF SECTION 26 50 10**

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**SECTION 27 05 24**  
**DIGITAL VIDEO RECORDING SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION AND GENERAL SPECIFICATIONS**

- A. Provide the equipment, materials, and labor to install the systems shown on the Drawings and specified herein. This shall include (but not be limited to) provision of all cameras, servers, workstations, storage arrays, software, programming, raceways, wire, cable, cabinets, boxes, line and low voltage Wire and Cable, patch cords, terminal modules, panels, outlets, jacks, connections, cable management, labeling, testing and all other material, equipment, and labor required to make the systems fully operational.
- B. The intent of this Specification is to place in working order a complete, fully tested and documented CCTV System and Digital Video Recording System capable of tight integration with the Security Management System provided in accordance with Specification Section 28 13 33. The CCTV System and Digital Video Recording System shall comply with the Codes and Standards referenced herein and with the manufacturer's installation instructions and requirements.

**1.2 DEFINITIONS**

- A. DVRS – Digital Video Recording System
- B. RU – Rack Unit (1-3/4 inches of rack or cabinet space)
- C. IPTV – Internet Protocol Closed Circuit Television

**1.3 PROJECT SUMMARY**

- A. The project consists of the installation of a Digital Video Recording System (DVRS) in the Library, Archives, and Museum Building for the State of Alaska in Juneau, Alaska.
- B. The DVRS shall be a network video solution, utilizing a standard IP-based network infrastructure to transport and record digitized video signals from security cameras. The system will allow authorized users to view live and recorded video either locally within the building or remotely through a web interface.
- C. IP cameras shall be used to capture the live video images of the areas under surveillance and shall stream digitized video signals over Category 6A cable to Ethernet network switches in the Main Telecom Room and the Satellite Telecom Rooms.
- D. Utilize fiber optic cable provided in accordance with Specification Section 27 20 10 and the Contract Drawings to interconnect the Ethernet switches in the Satellite Telecom Rooms and the Digital Video Recording System Archive Server located in the Main Telecom Room to store the digital video images from the local cameras.
- E. The system shall be capable of monitoring both live and recorded video on authorized PC workstations, using the Security Management System's client software.
- F. Connect the cameras, telecom horizontal cables, patch cords, fiber optic cable, fiber optic cable patch cords, Ethernet network switches, the Digital Video Recording System (DVRS) Archive Server, and monitoring workstations to form a complete and physically separate Digital Video Recording System/Security Management System (SMS) network on dedicated fiber optic cable backbone provided for this purpose in accordance with Specification Section 27 20 20.
- G. The project includes installation of video surveillance equipment, the structured cabling system infrastructure transport, a grounding and bounding system, and electrical components to support the system.

#### 1.4 WORK INCLUDED

- A. Furnish all labor, equipment, wiring, supplies, materials, and programming required for the installation of a complete and operational Digital Video Recording System in accordance with these Specifications and the drawings. Provide system programming, test and checkout, and training for the work specified herein and detailed on the drawings.
- B. The work of this section shall include, but not be limited to furnishing and installing the following:
  - 1. Indoor, Fixed Digital (IP) Color Cameras.
  - 2. Outdoor Fixed Digital (IP) Lowlight Color Cameras.
  - 3. Varifocal Lens.
  - 4. Camera Housings.
  - 5. Camera Mounts.
  - 6. Video Management Software.
  - 7. Video Management GUI
  - 8. CCTV camera power supplies.
  - 9. Provide Category 6A UTP patch cords for interconnecting Category 6A horizontal cables to cameras in accordance with Specification Section 27 20 10.
  - 10. Provide Category 6A UTP patch cords for interconnecting Category 6A horizontal cables at telecom patch panels to the Ethernet network switches and Digital Video Recording System Archive Server in accordance with Specification Section 27 20 10.
  - 11. Provide fiber optic cable patch cords used to interconnect the Ethernet network switches to the fiber optic backbone cables in accordance with Specification Section 27 20 20.
  - 12. Electrical boxes and raceways at device locations and equipment cabinets as necessary for mounting devices and interconnecting equipment.
  - 13. Firestopping pathways that penetrate fire rated walls, floors, and ceilings.
  - 14. Ancillary materials, including cable, wire and connectors required to provide a complete and operational system.
  - 15. Grounding and bonding of installed equipment.

#### 1.5 RELATED SECTIONS

- A. Section 01 79 00 - Demonstrations and Training
- B. Section 01 91 00 - Commissioning
- C. Section 27 20 10 - Telecommunications Distribution System
- D. Section 27 20 20 - Telecom Optical Fiber Distribution
- E. Section 28 13 33 - Security Management System
- F. Section 28 31 13 - Addressable Fire Alarm System

#### 1.6 REFERENCES

- A. Materials and workmanship shall conform to the latest issue of industry standards, publications, or regulations referenced in this section.
- B. MPEG-4 Part 10 Video Compression Standard.
- C. M-JPEG 10 Video Compression Standard.
- D. IEEE 802.3ab Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Gigabit Ethernet Network.
- E. IEEE 802.3af Power-over-Ethernet (PoE) Standard.
- F. IEEE 802.3g Wireless LAN Standard.
- G. IEEE 802.1Q VLAN Trunking Protocol.
- H. IEEE 802.1 Quality of Service (QoS).
- I. ASTM E-814 Fire Tests of Through-Penetration Fire Stops.

- J. UL 1479 Fire Tests of Through-Penetration Firestop.
- K. NFPA 70 - National Electrical Code (NEC).

### 1.7 COORDINATION

- A. Coordinate the work of this section with the Department as required to ensure that the entire work of this project is carried out in an orderly, complete and coordinated fashion.
- B. Supply required supervision and coordination of information to accommodate the work of this section and minimize interferences.
- C. Field coordinate the exact mounting location and Field of Views (FOV) for each camera with the Department prior to installation.
- D. The locations of DVRS and CCTV equipment are diagrammatically expressed on the drawings. Exact locations of items of work shall be field coordinated. Report major discrepancies between locations of devices on the drawings and within the field to the Department within three days.

### 1.8 INTENT OF DRAWINGS

- A. The drawings are diagrammatic unless detailed dimensions are included. Drawings show close approximate locations of equipment and devices. Exact locations are subject to the approval of the Department.

### 1.9 SUBMITTALS

- A. Product Data and Shop Drawings
  - 1. Submittals shall include product data literature and shop drawings. Submittals shall include adequate descriptive literature, catalog cut sheets, shop drawings and other data necessary for the Department to ascertain that the proposed equipment and materials comply with specification requirements.
  - 2. Product data Submittals shall consist of catalog cut sheets, technical data sheets, manufacturer specifications, brochures and/or diagrams necessary to illustrate a product, material or system for some portion of the work. Product data literature is required on all items of material and equipment and should be clearly marked, identifying specific items proposed.
  - 3. Shop drawings shall include floor plans showing the exact locations of cameras and detailed elevation views of layouts within the Main Telecom Room and the Satellite Telecom Rooms showing equipment cabinets. Shop drawings shall be created using AutoCAD, version 2011 minimum.
  - 4. Prior to assembling or installing the work, prepare and submit shop drawings and product data literature for review and approval by the Department.
- B. Calculations
  - 1. Bandwidth Calculations: Provide bandwidth calculations for the digital cameras using the frame rates, resolution and video compression standards specified and submit to the Department for review and approval prior to construction. These bandwidth calculations will be used to verify that the specified backbone cable and related infrastructure meets the required needs of the system.
  - 2. Recording Storage Calculations: Provide recording storage calculations for the system using the total number of digital cameras, frame rates, resolution and video compression standards specified and submit to the Department for review and approval prior to construction. These storage calculations will be used to verify that the specified storage meets the minimum required storage retention time as specified below.
- C. The Contractor shall not purchase any materials or equipment prior to receipt of appropriately reviewed and approved Submittals from the Department.

- D. Review of product data shall not relieve the Contractor from responsibility for deviations from the drawings or specifications, unless the Contractor has, in writing, called attention to such deviations at the time of submission and secured written approval.
- E. The Contractor shall develop and submit complete Submittals and do so in a timely manner. By failing to do so, the Contractor agrees to be fully responsible for any and all damages which might be incurred by the Contractor's failure to do so.
- F. Submittals shall include four (4) copies of Product Data Submittals and Shop Drawings.
- G. Quality Control/Control Submittals:
  - 1. Pre-functional Installation (PC) and Functional Performance Test (FT) Checklists in accordance with Section 01 91 00 – Commissioning.

#### **1.10 REGULATORY REQUIREMENTS**

- A. Work shall conform to the requirements of NFPA 70 and all local amendments.
- B. Work shall conform to the requirements of Federal, State and Local Electrical and Telecommunications Regulations.

#### **1.11 QUALITY CONTROL**

- A. Equipment shall meet or exceed the minimum requirements of NEMA, ASME, ANSI and Underwriters Laboratories.
- B. Material and equipment furnished shall be new and unused and free from defects. Equipment shall be clean and free of damage or corrosion, and shall be of the best quality obtainable for the purpose intended.
- C. Specified items of equipment or material shall be the product of one manufacturer throughout the facility. Multiple manufacturers of any one item are not permitted, unless specifically noted otherwise and approved in writing by the Department.
- D. System hardware and software components shall be produced by a manufacturer regularly engaged in the production of Closed Circuit Television Systems and Digital Video Recording Systems equipment for a minimum period of 5 years.
- E. Perform Work in accordance with regulatory rules and regulations as well as references in this specification.

#### **1.12 CONTRACTOR QUALIFICATIONS**

- A. The Closed Circuit Television (CCTV) and Digital Video Recording System (DVRS) work specified in this Section is acknowledged to require special skills mastered by education, experience, or both. Bidders for the work described in this Section shall be specialty Contractors, who may be a division of the Divisions 26, 27 and 28 subcontractor.
- B. The installing Contractor shall be a company specializing in the design, installation, and testing of electronic security systems and specifically CCTV and DVRS systems.
- C. The installing Contractor shall have a minimum of three years of experience in this specialized field and shall have completed a minimum of three projects similar in scope to this project.
- D. Work shall be performed by qualified individuals having at least three (3) years experience installing and/or maintaining CCTV and DVRS systems. The qualified individuals shall have completed installation of at least two (2) systems of 25 cameras or more within the past five (5) years. Submit evidence of successful installation, Department training and maintenance for a minimum of the previous five years. Provide listing of projects with verifiable references with names and telephone numbers. Qualified individuals shall be factory trained for the systems being provided as part of this Contract. Submit evidence of successful factory training no later than 30 days from Notice to Proceed.

### 1.13 WARRANTY

- A. Work shall be guaranteed to be free from defects. Defective materials or workmanship shall be replaced or repaired as directed by the Department for the duration of the stipulated guarantee period.
- B. Warrant labor, workmanship, and materials provided under this Contract for a minimum period of 1 year from date of Final Completion or as specified elsewhere in these specifications.
- C. If items supplied as part of this project have longer warranties, the Contractor shall match the longer warranty duration from the date of Final Completion.
- D. If other individual Specification Sections require longer warranty, the Contractor shall match the longer warranty duration from the date of Final Completion.
- E. Guarantee in writing all phases of the work against defective materials and workmanship. Should a failure occur within the warranty period, the CONTRACTOR shall provide all labor and materials necessary to restore the system to its' full and operating condition at no cost to the Department.

### 1.14 MAINTENANCE AND SERVICE

- A. General Requirements: Provide services and equipment necessary to maintain the entire DVRS system in an operational state as specified for a period of 1 year after Final Completion of the system. Provide all necessary material required for performing scheduled maintenance or other nonscheduled work.
- B. Response Times: For the warranty period the following response times shall be maintained:
  - 1. The initial call to the Contractor shall require the type of call to be classified as critical or non-critical. The nature of the problem and the effect on operations shall be the deciding factor in classifying the problem. For the purpose of defining the priority of the call, the Contractor shall have personnel accessible to facility personnel via phone call-back within one (1) hour of initial call.
    - a. Non-critical Items: These are defined as failures or problems that do not effect the overall safety, security, or operation of the facility.
    - b. Critical Items: These are defined as failures or problems that do effect the overall safety, security, or operation of the facility. The failure of a primary server would be an example of a critical item requiring immediate remedy.
  - 2. Non-critical items: The Contractor shall diagnose and remedy the problem during normal working hours of the next working day. The initial response shall be the morning of the next day if received before noon or by the noon the next day if received before close of business. Normal business hours are defined as 8 AM to 4 PM Monday through Friday.
  - 3. Critical Items: Critical items require the Contractor to respond in an expeditious manner. The Contractor shall be on-site within four (4) of the initial call. These calls may need to be responded to outside of normal business hours.
- C. If the Contractor fails to respond to the service request within the specified time, the facility or Department will have the right to repair the system without invalidating the warranty. In the event the Department affects repairs because of Contractor non-response, the Contractor will be charged for the repair cost.
- D. Software Upgrades: CONTRACTOR shall install any updates to the manufacturer's software for the DVRS equipment throughout and up to the end of the warranty period at no cost to the DEPARTMENT.

### 1.15 TRAINING

- A. Provide on-site training by a qualified, factory-trained instructor for designated operation personnel and maintenance technicians on the operation and maintenance of the system. If trained personnel from the factory are required for training, they shall be provided on-site by the Contractor at no additional cost to the Department.

- B. Provide the following training upon completion of final testing and acceptance of the system:
  - 1. Demonstrate operation of system in all modes of operation.
  - 2. Provide minimum of 8 hours of system maintenance training to designated personnel. Classes shall accommodate up to five (5) students at one time. Provide two separate classes, if required, to accommodate separate maintenance shifts.
  - 3. Maintenance training shall cover all operations and technical training required for maintenance, preventative maintenance and system adds, moves and changes including detailed instructions on system software modifications.
  - 4. Provide minimum of 8 hours of operator training to system operators. Classes shall accommodate up to five (5) students at one time. Provide two separate classes, if required, to accommodate separate operator shifts.
  - 5. Provide course syllabus for all training courses in advance of each course, with an outline of the topics, time allotted for each topic, targeted audience and training objectives. Submit training manuals to the Department for review and approval a minimum of ten (10) working days in advance of scheduled training. Training shall not commence until training syllabus has been approved.
  - 6. Provide a sheet accompanying any training that includes basic system terminology and definitions.
  - 7. Training materials shall be of professional industry standard quality and provided in both hard and soft copy.

#### 1.16 RECORD DOCUMENTATION

- A. Record documentation shall include:
  - 1. Operation and Maintenance (O&M) Manuals. (Hard and soft copy)
  - 2. Complete set of record as-built shop drawings. (Hard and soft copy)
  - 3. Complete test reports. (Hard and soft copy)
- B. Operation and Maintenance (O&M) Manuals.
  - 1. Upon completion of the project, submit a complete set of product data sheets for all products installed. Product data sheets shall be clearly marked, identifying the specific items installed.
  - 2. Where applicable, submit operations manuals and maintenance manuals for active and passive components of the installed systems.
  - 3. Submit four (4) identical sets of O&M Manuals.
- C. See Section 01 91 00 – Commissioning for product and O&M manual submittal sequencing.
- D. Record Drawings
  - 1. Maintain a complete set of contract drawings. Use this set of drawings for showing as constructed installation of systems and equipment. Plans shall include, but not be limited to, showing exact location and heights of devices, and appropriate identification. Detail drawings shall show exact locations of equipment racks, cross-connects, and any other pertinent details.
  - 2. Where material, equipment, wiring or system components are installed differently from that shown on the bid drawings, show such differences clearly and neatly.
  - 3. This set of drawings shall be kept up to date as the job progresses and shall be made available for inspection by the Department at all times.
  - 4. Upon completion of the project, incorporate this set of drawings with as constructed details into the Shop Drawings using AutoCAD, version 2011. Submit four (4) full-size sets of drawings and the AutoCAD drawing files on CD-ROM to the Department
- E. Test Reports
  - 1. The Contractor shall be responsible for recording test data. Copies of test results shall be submitted for review by the Department as part of final acceptance and subsequently submitted to the Department for their records.
  - 2. Submit test reports in both printed format and an electronic format to assist the Department in the final review process. Printed test reports shall be provided in 8-1/2" x

- 11" format in three ring binders. Electronic copies of the test reports shall be in PDF format.
3. Refer to the testing section of the specifications for details on the data that shall be included in the test reports.
  4. Submit one (1) printed copy of the test reports and three (3) electronic copies of the test reports on separate CD-ROMs to the Department.

### **1.17 DIGITAL VIDEO RECORDING SYSTEM SCOPE OF WORK**

- A. System Architecture
  1. The Digital Video Recording System shall be a network video solution, utilizing a standard IP-based network infrastructure to transport and record digitized video signals from security cameras. The system shall allow authorized users to view live and recorded video either locally within the building or remotely over a web interface.
  2. Provide IP cameras at the locations shown on the drawings to capture live video images of the areas under surveillance.
- B. Camera Power Cabling
  1. Provide exterior cameras with built-in heaters and blowers available from the manufacturer for keeping the enclosed camera at operating temperature during cold or otherwise adverse weather. If these heaters and blowers increase the power required at each camera beyond the 15.4 watts that can be delivered from an IEEE 802.3af compliant Power over Ethernet (PoE) network switch, then the Contractor shall provide an external power supply and separate cables for powering of the heater and blowers in accordance with this Specification. Submit for approval proposed power circuits.
  2. Interior cameras shall be powered over the Category 6A cable provided in accordance with Specification Section 27 20 10 from Power-over-Ethernet (PoE) compliant Ethernet network switches provided in accordance with this Specification.
- C. Video Recording
  1. The digitized video signals transported from the IP cameras over the network shall be stored and recorded on a DVRS Archive Server located within the Main Telecom Room.
  2. Digitized video signals shall be recorded on the DVRS Archive server for retrieval at a later date as required. Retention time of the stored digital images shall be a minimum of 30 days before being written over.
  3. Provide the Security Management System software on the DVRS Archive Server for managing the live, recorded, and stored DVRS video.
- D. Monitoring and Control
  1. The system shall provide monitoring of both live and recorded video on authorized PC workstations, using the Security Management System's client software.
  2. Furnish and install the Security Management System software on the PC workstations in the locations indicated on the drawings and in this Specification.
  3. The system shall also be capable of monitoring both live and recorded video on authorized remote workstations. The system shall be capable of transmitting digital video signals from the local archive server or directly from IP cameras from the SMS/DVRS dedicated Ethernet LAN and allow remote viewing of live images via the optional web interface.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain. If items are damaged, do not install, but take immediate steps to obtain replacement.
- B. Acceptable Manufacturers and Substitutions

1. Named manufacturers are the basis of design for this system.
2. The Contractor may submit a request for approval of equal products or materials. The request shall include product literature and a complete compliance checklist with individual specification paragraph performance requirements. The request shall be submitted to the Department for review and possible approval in accordance with specification requirements.

## 2.2 TYPE A - FIXED IP COLOR CAMERA

### A. General

1. Camera shall be IP based and fully integrated and managed through a system software package.
2. Camera shall feature a built-in digital motion detector with alarm output.
3. Minimum Specifications:
  - a. Compression: H.264 and Motion JPEG
  - b. Resolution: 1280x800 pixels.
  - c. Frames Per Second:
    - 1). 30 fps in all resolutions
  - d. Image Sensor: 1/4" Progressive scan RGB CMOS
  - e. Lens type mount: CS
  - f. Lens: Fujinon, F1.3 varifocal 5-50mm, DC-iris, Focus range: 0.3 m to infinity.
  - g. PoE compliant: 802.3af
  - h. Mounting: Ceiling/wall mounted dome enclosure
  - i. Enclosure: dome
  - j. Power: Power over Ethernet (PoE) from Ethernet network switches
  - k. Connectors: Ethernet 10BaseT/100BaseTX, RJ-45, Mini DC power jack, Terminal block for 1 alarm input and 1 output, 3.5 mm jack for Mic or line mono input, 3.5 mm jack for line mono output to active speaker.
  - l. Camera angle adjustment: Pan 360 degrees, tilt 170 degrees, rotation 340 degrees.
4. Acceptable Manufacturers
  - a. Axis Communications: Model 3344 or approved equal for indoor locations, Model 3344-VE or approved equal for outdoor locations.

## 2.3 TYPE B - FIXED IP COLOR CAMERA

### A. General

1. Camera shall be IP based and fully integrated and managed through a system software package.
2. Camera shall feature a built-in digital motion detector with alarm output.
3. Minimum Specifications:
  - a. Compression: H.264 and Motion JPEG
  - b. Resolution: 2048x1536 pixels.
  - c. Frames Per Second:
    - 1). 20 fps in all resolutions
    - 2). 30 fps at 1600x1200
  - d. Image Sensor: 1/3" Progressive scan RGB CMOS
  - e. Lens type mount: CS
  - f. Lens: Fujinon, F1.3 varifocal 5-50mm, DC-iris, Focus range: 0.3 m to infinity.
  - g. PoE compliant: 802.3af
  - h. Mounting: Ceiling/wall mounted dome enclosure
  - i. Enclosure: dome
  - j. Power: Power over Ethernet (PoE) from Ethernet network switches
  - k. Connectors: Ethernet 10BaseT/100BaseTX, RJ-45, Mini DC power jack, Terminal block for 1 alarm input and 1 output, 3.5 mm jack for Mic or line mono input, 3.5 mm jack for line mono output to active speaker.
  - l. Camera angle adjustment: Pan 360 degrees, tilt 170 degrees, rotation 340 degrees.

4. Acceptable Manufacturers
  - a. Axis Communications: Model 3346 or approved equal for indoor locations, Model 3346-VE or approved equal for outdoor locations.

## **2.4 CAMERA HOUSINGS**

- A. General
  1. Exterior cameras shall be mounted in weather proof vandal resistant dome enclosures.
  2. Enclosures shall include heater and blower function for exterior applications.
  3. Enclosures shall be capable of mounting to a pendant mount from a wall mount bracket, wall mount and ceiling mount.
  4. Dome shall be smoke tinted.
  5. Acceptable Manufacturers
    - a. Axis Communications or Dotworkz or approved equal.

## **2.5 CAMERA MOUNTING EQUIPMENT**

- A. General
  1. Exterior cameras shall be mounted in one of two manners: Wall, ceiling soffit mount, or pole mounted as noted on the drawings.
  2. Acceptable Manufacturers
    - a. Axis Communications or approved equal.

## **2.6 EXTERIOR CCTV CAMERA POLE MOUNTING EQUIPMENT**

- A. Where CCTV cameras are shown mounted on site lighting poles, provide a light pole manufacturer factory furnished and finished mounting bracket for the CCTV camera. Provide CCTV camera EPA and weight, CCTV mounting arm and weight to the lighting pole manufacturer for the proper sizing and structural calculation of the site lighting poles to properly support the combined weight of the poles, light fixtures, CCTV, and CCTV camera mounting arm. Provide dimensioned shop drawings to the light pole manufacturer for accurate placement of arm attachment holes and conduit cut outs. Coordinate specific requirements with the light pole manufacturer.

## **2.7 EXTERIOR CCTV CAMERA ENCLOSURE HEATER POWER SUPPLY**

- A. General
  1. Camera power supplies shall be rack mountable.
  2. Shall include 16 fuse protected outputs.
  3. Shall provide power for exterior camera enclosure heaters and other video accessories.
  4. Shall have outputs rated at 3.5 amp minimum for each output.
  5. Acceptable Manufacturers
    - a. Altronix #R2416UL or approved equal.

## **2.8 CCTV CAMERA WIRING**

- A. Interior cameras: Provide one telecommunication horizontal cable to each camera in accordance with Specification Section 27 20 10. Each camera's cabling shall be individually homerun in a dedicated conduit.
- B. Exterior cameras: Provide one telecommunication horizontal cable to each camera in accordance with Specification Section 27 20 10. In addition, provide one @ two #12 AWG conductor cable with an overall shield for providing power to the exterior camera enclosure heater; Belden 83802 or approved equal. Each camera's cabling shall be individually homerun in a dedicated conduit.

## **2.9 CATEGORY 6A PATCH CABLES**

- A. Provide in accordance with Specification Section 27 20 10.

## **2.10 FIBER OPTIC JUMPER CABLES**

- A. Provide in accordance with Specification Section 27 20 20.

## **2.11 SECURITY MANAGEMENT SOFTWARE**

- A. General
1. The Security Management Software (SMS) shall provide the ability to monitor all cameras and at the same time record the digital video images from all cameras.
  2. The SMS shall provide the following features:
    - a. Record continuously or on a schedule.
    - b. System shall use TCP/IP protocol for network communications.
    - c. System shall provide on-line help for operating system and application software.
    - d. System shall be capable of controlling Pan/Tilt/Zoom (PTZ) control of future PTZ CCTV cameras.
    - e. System shall provide video authentication capability.
    - f. Record on alarm and motion detection.
    - g. Support recordings in H.264 and Motion-JPEG.
    - h. Provide multi-view playback and viewing of simultaneous recordings from different cameras.
    - i. Provide the ability to be controlled from multiple user PC stations.
    - j. Produce an audit log.
    - k. Provide remote access via a web browser or windows client.
    - l. Provide multiple search functions for recorded events.
    - m. Provide live view of up to 16 cameras.
    - n. Provide record tampering warning.
    - o. Provide ability to move recordings to a remote storage device on a daily basis.
    - p. Provide video clip export capability.
    - q. Provide individual camera frame rate control.
  3. Acceptable Manufacturers
    - a. ONSSI
    - b. Genetec
    - c. Milestone
    - d. Or Approved Equal

## **2.12 DIGITAL VIDEO RECORDING SYSTEM (DVRS) GRAPHICAL USER INTERFACE**

- A. The DVRS shall be configured with a Graphical User Interface (GUI) as specified herein which minimizes training and operational needs for the operators. The software shall include on-line help displays to eliminate operator reference manuals. The GUI shall be an integral part of the DVRS and is what DVRS operators will use to interface with the DVRS.
1. The GUI shall represent each floor of the building separately.
  2. The GUI shall be zoned in accordance SMS GUI zoning shall show every camera in the building and in each zone such that a DVRS system operator can see a SMS alarm on their SMS workstation and click on an appropriate camera icon on their DVRS GUI and bring up live and recorded video for that camera.
  3. The GUI shall utilize the same base maps as the GUI for the Security Management System in accordance with Specification Section 28 13 33.
  4. The GUI shall show every CCTV in the building with its corresponding CCTV camera label and the SMS zoning as indicated on the Drawings.
  5. Coordinate design of GUI base maps with the Department prior to final deployment and commissioning of system.

### 2.13 ETHERNET NETWORK SWITCHES

- A. Provide layer three switches at interior locations as shown on the Contract Drawings. Equip each switch with two 1000Base-LX/LH GBIC adapters.
- B. Acceptable Manufacturer/Model shall be Cisco 3750E-24-PD, no substitutions.

### 2.14 CCTV ARCHIVE SERVER

- A. General
  - 1. The CCTV Archive Server shall store all recorded CCTV digital video images from all cameras.
  - 2. Server shall be Windows 2008R2 SP1 Server based and shall control all data flow.
  - 3. Server processor shall be an Intel processor.
  - 4. Server shall have dual redundant hot swappable power supplies.
  - 5. The CCTV Archive Server shall have the following characteristics:
    - a. Operating Software: Windows Server 2008R2 SP1
      - 1). CPU: Intel Quad Core Xeon L5620 processor, 2.40 Ghz, 12Mb cache, 1066 Mhz FSB
      - 2). RAM: 16 GB (4 x 4GB), 1333MHz DDR3.
      - 3). Hard Drive 1: 500 GB, 7,200 RPM, SATA
      - 4). Additional hard drives: 2@ 2 TB, 7,200 RPM, SATA (formatted as one partition for internal storage of archive video).
      - 5). DVD +/- RW, SATA
      - 6). Monitor: Flat panel (23" viewable)
  - 6. Mouse: 2-button with wheel
  - 7. Acceptable Manufacturers
    - a. Dell Power Edge R710 or manufacturer approved equal

### 2.15 CCTV CLIENT WORKSTATION

- A. General
  - 1. The CCTV Client User Workstation (CUW) shall be the device that the Security Management Software is loaded on.
  - 2. The CUW shall be the device that provides the interface to the CCTV Security System.
  - 3. The CUW shall provide the ability to program, control and view live and recorded CCTV digital video images from all cameras.
  - 4. The Security Management Software shall be installed on the CUW by the CONTRACTOR.
  - 5. The CUW shall have the following characteristics:
    - a. CPU: Intel dual core processor
    - b. Operating Software: Windows XP
      - 1). RAM: 2 GB.
      - 2). Hard Drive: 500 GB
      - 3). Graphics Card: 512 MB
      - 4). Monitor: Flat panel (23" viewable)
  - 6. Mouse: 2-button with wheel
  - 7. Acceptable Manufacturers
    - a. HP
    - b. Or Approved Equal

### 2.16 FREE STANDING ENCLOSED EQUIPMENT CABINETS

- A. Provide in accordance with Specification Section 27 20 10.

## **2.17 SPECIAL EQUIPMENT**

- A. Special hardware, software, tools, test equipment, programming or initialization equipment required to modify or maintain any part of the CCTV System or its components shall be provided as part of the CCTV System.

## **2.18 UNSPECIFIED EQUIPMENT AND MATERIAL**

- A. Any item of equipment or material not specifically addressed on the Drawings or in this document and required to provide a complete and functional CCTV System and DVRS System shall be provided in a level of quality consistent with other specified items.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install equipment in strict accordance with the manufacturer's recommendations.
- B. The installation shall comply with the requirements of NEC, OSHA and the rules, regulations and requirements of the FCC.
- C. The installation shall also comply with federal, municipality, and state laws, ordinances, regulations, and codes applicable to the installation.
- D. Ground all DVRS/CCTV equipment installed to the grounding bus bars provided in the CCTV equipment cabinets.
- E. Wiring at cameras shall be concealed and not exposed. Install wiring through camera mounts and housing or conduit / flexible conduit where required.
- F. Provide labels on installed equipment. Labels shall be permanent, waterproof, and readable from one foot with permanent lettering and shall not be removable by normal cable handling or normal operations.
  1. Screws for junction boxes, pull boxes, and camera mounts and enclosures shall be tamper resistant.

### **3.2 CAMERA LOCATION SURVEY**

1. Survey each camera location using a portable camera(s) with a variety of suitable lenses, monitor(s) and a portable power supply to power the equipment. Supply all required equipment and wiring for the survey.
2. Field verify with the Department the exact mounting locations and camera field-of-views for each camera prior to installation.
3. Prepare forms to document information, such as names of participants, date of survey, camera location information, desired field of view, lenses selection, proposed mounting configuration and any other information as may be required.
4. Incorporate data from survey into installation of cameras.

### **3.3 CONFIGURATION AND PROGRAMMING**

1. Provide software, software licenses and programming for a complete and fully operational DVRS system, including but not limited to, system interfaces, graphics development, and camera setup.
2. The Contractor, based on its technical expertise and experience on previous projects, shall be responsible for the development of programming matrices. Enter all data needed to make the system operational.
3. Identify and request from the Department any additional data needed to provide a complete and operational DVRS. Submit request to the Department 30 days prior to programming the system. The Department shall provide in writing to the Contractor 14 days prior to programming any additional details for configuring the system.

4. Program and configure the system according to the specifications and drawings and any additional Department requirements. The parameters to configure include, but are not limited to:
  - a. Camera Frame Rates
  - b. Video Resolution
  - c. Video compression
  - d. Image quality / compression ratio
  - e. Video Motion Detection
  - f. Continuous and Event recording
  - g. IP addressing according to the Department's IP scheme
  - h. Security Management System on archive server and viewing workstations
  - i. Camera Field of Views from the camera survey
  - j. Security settings such as password protection
  - k. Operator and Administrator levels for users
  - l. Monitor call-ups, if required
5. Program and configure the Video Management software on the Archive Server and to record and manage the video.
6. Program and configure the Client Video Management software on the Monitoring/Control Workstations to enable users to view live and recorded video and control future PTZ cameras. Programming shall include, but not be limited to:
  - a. Setting passwords protection on the client software
  - b. Setting access levels such as administrator, operator or viewer.
  - c. Monitor modes such as multi-camera display, full screen view or camera sequencing
7. Create, develop, and install all graphics required to make the system operational.
  - a. Graphics shall have sufficient level of detail for personnel to operate the system.
  - b. Supply hard copy, color examples at least 8½ inches by 11 inches in size, of each type of graphic to be used for the completed DVRS.
  - c. Provide examples of the video annotation used for camera identification.
  - d. The graphics examples shall be submitted to the Department for review and approval at least 30 days prior to the Contractor programming the system.
8. Include in the Bid required costs for eight hours of software modifications based on additional Department input and direction from the Department at time of system acceptance.

### **3.4 SYSTEM OPERATION**

1. The system shall provide continuous recording of video signals from cameras during normal facility hours and event recording after hours. Event recording shall be triggered by the use of Video Motion Detection either directly at the camera or programmed into the Video Management System. Coordinate with the Department on the exact hours to program into the system for continuous and event recording.
2. The system shall automatically send notification to facility personnel via email upon activation of event recording after hours.
3. The system shall use non-proprietary versions of H.264 and M-JPEG video compression standards to allow the system to integrate with standard IP-based networking and PC equipment.

### **3.5 TESTING**

1. Preparation
  - a. Prior to Final Acceptance Testing inspect items of equipment and systems to ensure that:
    - 1). Installation is in accordance with manufacturer's instructions and recommendations.
    - 2). No defective items have been installed and there are no loose connections.
    - 3). System software and firmware are completely installed and fully operational.

- b. Provide and submit evidence of their completion of the manufacturer's checklists or test procedures.
  - c. Cabling is properly labeled, neat, and properly secured.
  - d. Power supplies are correct voltage, phasing, and frequency.
  - e. Grounding and transient protection systems are properly installed.
  - f. System documentation is complete, accurate, and has been properly submitted.
2. Test Plan
- a. The Contractor shall prepare a Test Plan. The approved Test Plan shall serve as the basis for the detailed test procedures used in the field.
  - b. The Test Plan shall:
    - 1). Include an overall testing schedule for tests to be performed.
    - 2). Describe the schedule and method by which the Contractor shall perform testing of the system.
    - 3). Describe the types of test equipment, software, hardware, and simulators, proposed for each testing phase.
    - 4). Define and detail the test methodology for verifying the system requirements, satisfying the performance and availability criteria, and satisfying the Specifications.
  - c. Update the Test Plan as necessary and obtain the Department's written acceptance of the Test Plan prior to beginning any testing.
3. Testing
- a. Provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.
  - b. Written notification of planned testing shall be given to the Department at least 14 days prior to the test, and in no case shall notice be given until after the Contractor has received written approval of the specific Test Plan.
  - c. Ensure that test procedures confirm each specification statement and manufacturer requirement has been met or exceeded. An actual demonstration of each system function and a simulation of each system failure shall be provided.
  - d. An acceptance test period of thirty days shall begin at the start of the acceptance test. Any system failure during the acceptance test period will suspend the acceptance test. The thirty-day test period will restart when the required repairs have been made and certified.
  - e. Perform tests in the presence of the Department. The Department reserves the right to accept any portion or activate any phase prior to acceptance of entire system.
  - f. As part of the field testing, make a DVD recording showing typical day and night views of each camera in the system and deliver the DVD with the report to the Department. The DVD shall be recorded using the R/W DVD installed at the site. Submit the original DVD to the Contracting Agency as part of the documentation of the system.
  - g. The field testing shall as a minimum include:
    - 1). Verification that the video and signal or control cabling has been installed, tested, and approved.
    - 2). Verification that the DVRS is fully functional.
    - 3). Operation of all electrical, mechanical and software controls and verification that the control performs the designed function.
    - 4). Verification that all other ancillary and remote video equipment is functioning properly.
    - 5). Verification that video equipment with alarm indicators annunciate alarms properly and under the correct conditions.

### 3.6 FIRESTOPPING

- A. Firestop, per the applicable codes, fire-rated walls, floors or ceilings penetrated when installing the devices provided under this Specification Section.

- B. Provide fire resistant UL approved firestopping systems to restore fire ratings to all wall, floor or ceiling penetrations. Firestopping systems shall be UL classified and meet NEC and CBJ.
- C. Firestopping materials shall be installed in accordance with the manufacturer's directions and recommendations.

**3.7 DEMONSTRATIONS AND TRAINING**

- A. Provide Demonstrations and Training in accordance with Section 01 79 00 – Demonstrations and Training.

**END OF SECTION 27 05 24**

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**SECTION 27 20 10**  
**TELECOM DISTRIBUTION SYSTEM (TDS)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION AND GENERAL SPECIFICATIONS**

- A. Provide the equipment, materials, and labor to install the systems shown on the Drawings and specified herein. This shall include (but not be limited to) provision of all trenching and backfill, raceways, sleeves, boxes, gutters, shelves, enclosures, shelf and enclosure supports, backboards, equipment racks, line and low voltage wire and cable, patch cords, pull ropes (in unused conduits), terminal modules, panels, outlets, jacks, splices, connections, cable management, labeling, testing and all other material, equipment, and labor required to make the systems fully operational.
- B. The intent of this Specification is to place in working order a complete, fully tested and documented Category 6A (augmented Category 6) system complying with the Codes and Standards referenced herein.

**1.2 RELATED SECTIONS**

- A. 01 91 00 - Commissioning
- B. 26 05 34 - Conduit and Fittings
- C. 26 05 36 - Cable Tray
- D. 27 20 20 - Telecommunications Optical Fiber Distribution

**1.3 COORDINATION**

- A. The necessity to coordinate this work with the Serving Utility, Department and the Department is emphasized. The Contractor shall be responsible for any omissions, delays and additional cost due to lack of coordination or approval from the same.
- B. Coordinate work with other Contractors and trades. The layout and installation of the systems shown on the Drawings and specified herein shall be coordinated such that all special requirements for telecommunications systems shall be provided and incorporated into the project. The systems to be coordinated shall include (but are not limited to) electrical raceway, grounding, fire rated assembly, lighting, power distribution, control and instrumentation, and labeling of cables, terminations, outlets, jacks, etc. Report all conflicts to the Department.

**1.4 CODES AND STANDARDS**

- A. Where a Nationally Recognized Testing Laboratory (NRTL) listing or classification exists for a product and the product is suitable for the purpose specified and indicated, the product shall bear the appropriate marking indicating the listing or classification.
- B. Where a UL Standard is in effect, equipment shall:
  - 1. Meet that Standard.
  - 2. Bear the UL Label.

**1.5 SUBMITTALS**

- A. The following shall be submitted in accordance with Section 26 00 00 - Electrical General Requirements and Division 1 in sufficient detail to show full compliance with the specification:
  - 1. Manufacturer's Catalog Data shall be submitted for the following items. Data shall include a complete list of parts, special tools, and supplies.
    - a. Copper Cable.
    - b. Splice Cases.

- c. Information Outlets.
  - d. Patch Panels.
  - e. Equipment Racks.
  - f. Terminal Modules.
  - g. Patch Cords and other accessories.
2. Manufacturer's Installations Instructions.
  3. Labeling System: Coordinate with the Department for the Department's labeling conventions. Submit Project labeling system for approval.
  4. Contractor qualifications and experience as specified in this Section.
  5. Manufacturer's Warranty as specified elsewhere in this Section, including all warranty provisions and procedures for Department to follow to obtain warranty service
  6. Quality Control Plan: Contractor shall prepare a Quality Control plan which provides a detailed outline of all testing to be accomplished.
  7. The Quality Control Plan shall include, as a minimum:
    - a. A schedule of when tests will be performed relative to installation milestones.
    - b. Specific test procedure that will be used.
    - c. A list of test equipment that will be used including manufacturer, model number, calibration certification, range and resolution accuracy.
    - d. A sample test report form with examples of data to be reported.
    - e. Test plan shall be submitted to the Department for approval at least 30 days prior to the start of testing.
- B. DELETE SUPERFLUOUS INFORMATION FROM SUBMITTAL DATA, SUCH AS MODEL NUMBERS AND OPTIONS FOR EQUIPMENT CONTAINED ON MANUFACTURER'S DATA SHEETS BUT NOT USED ON THIS PROJECT.
- C. One copy of approved Submittals shall be kept at the job site.

#### 1.6 SHOP DRAWINGS

- A. Work shall be laid out in advance. Shop drawings shall be submitted to the Department for approval before work begins.
- B. Shop Drawings shall include dimensioned layout of Telecommunications Rooms, including backboards, patch panels, grounding terminal bus bars, ladder racking, equipment, etc. Layouts shall show Lighting Fixtures, HVAC equipment, etc., which affect room layouts.
- C. Shop Drawings shall include dimensioned layout of major pathways for backbone and horizontal cables, including large conduits (2 inch and larger) and sleeves.
- D. Work under this section has been indicated on the Drawings in locations that should allow installation without interfering with the work of other trades; however, exact finish locations cannot be indicated. Therefore, locations of all work and equipment shall be verified to avoid interferences, preserve headroom and keep openings and passageways clear. Review the plans for the work of the other trades and coordinate adjustment of this work, the work of the other trade or both to achieve the best installation for the Department without additional claims or charges. Shop Drawings shall reflect coordination of work under this Section with the work of other trades.

#### 1.7 REFERENCE CODES AND STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only, latest edition. The reference codes and standards are minimum requirements.

Reference	Title/Revision
ANSI/ICEA	Publication S-80-576

Reference	Title/Revision
ANSI/IEEE C2	National Electrical Safety Code
ANSI/NFPA 70	National Electrical Code
ANSI/T1E1.7/92-004R	Electrical Protection Applied to Telecommunications Network Plant at Entrances to Customer Structures or Buildings
ANSI/TIA/EIA-568-B.1	Commercial Building Telecommunication Cabling Standard Part 1: General Requirements
ANSI/TIA/EIA-568-B.2	Commercial Building Telecommunication Cabling Standard Part 2: Balanced Twisted-Pair Cabling Standards
ANSI/TIA/EIA-569-A	Commercial Building Standards for Telecommunications Pathways and Spaces
ANSI/TIA/EIA-571	Environmental Considerations for Telephone Terminals
ANSI/TIA/EIA-606-A	Administration Standard for Commercial Telecommunications Infrastructure
ANSI/TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications
ANSI/TIA/EIA-854-2001	A Full Duplex Ethernet Specification For 1000Mbps (1000base-Tx) Operating Over Category 6 Balanced Twisted-Pair Cabling
BELLCORE TR-EOP-000063	Bellcore Network Equipment Building Systems Generic Equipment Requirements
BICSI	Telecommunications Distribution Methods Manual
CFR 47 Part 68	Connection of Terminal Equipment to the Telephone Network
FCC Part 15	Radio Frequency Devices
FCC Part 68	Connection of Terminal Equipment to the Telephone Network
IEEE	LAN Standards: 802.3; 802.4; 802.5; 802.6
IEEE C62.41	Recommended Practice on Surge Voltages in Low-Voltage Surge Protective Devices
IEEE C62.42	Guide for the Application of Gas Tube Arrester Low-Voltage Surge Protective Devices
IEEE Draft P1250 (D4)	Guide on Service to Equipment Sensitive to Momentary Voltage Disturbances
IEEE Std 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book)
IEEE Std 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book)
IEEE Std 241	Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book)
IEEE Std 446	Recommended Practice for Emergency and Stand-by Power Systems for Industrial and Commercial Applications (Orange Book)
NTP 638 - 3031 - 300 STD	Northern Telecom Practice "Bonding and Grounding QCF-Type Bond Clamps Description and Installation"
UL 1283	Electromagnetic Interference Filters
UL 1449	Transient Voltage Surge Protection

Reference	Title/Revision
UL 1459	Standard for Telephone Equipment
UL 1950	Standard for Information Technology Equipment, Including Electrical Business Equipment
UL 467	Grounding and Bonding Equipment
UL 497	Protectors for Paired Conductors for Communication Circuits
UL 497A	Secondary Protectors for Communication Circuits
UL 497B	Protectors for Data Communication and Fire Alarm Circuits
UL 910	Safety Test for Flame-Propagation and Smoke Density Values for Electrical and Optical- Fiber Cables

### 1.8 OPERATING CONDITIONS

- A. Electronic equipment designed for office environments and Telecommunications Rooms shall be rated for continuous operation under ambient environment conditions of 10 degrees C (50 degrees F), to 30 degrees C (85 degrees F) and 35 to 65 percent relative humidity, non-condensing.

### 1.9 QUALITY CONTROL

- A. Perform Work in accordance with regulatory rules and regulations as well as references in this specification.
- B. Perform Testing in accordance with ANSI/TIA/EIA-568-B specifications and submit printed reports.

### 1.10 QUALIFICATIONS

- A. The telecommunications work specified in this Section is acknowledged to require special skills mastered by education, experience, or both. Bidders for telecommunications work described in this Section shall be specialty telecommunications Contractors, who may be a division of the Divisions 26, 27 and 28 subcontractors.
- B. Contractor Certification:
1. This subcontractor shall be a certified Commscope Systimax Business Partner, pre-qualified by the Manufacturer for the purpose of offering the Systimax SCS 20-year warranty as required in this Section.
  2. Provide a signed statement indicating that the subcontractor has the ability to provide the service required by the Contract Documents using factory trained and qualified technicians for each major system type and intends to maintain that capability until the end of the guarantee period.
- C. Contractor Experience:
1. Specialty subcontractors bidding telecommunications work shall have a minimum of five years experience in the construction, testing, and servicing of systems of the type and magnitude specified herein.
  2. Specialty subcontractors shall have completed at least three projects equal or larger in size than this project within the past five years.
  3. Submit three experience projects and a list of the tools and test equipment (indicating Department ship) expected to be used on this project within 30 days after contract award to demonstrate experience and access requirements.
  4. For each experience project submitted, provide the following information:
    - a. Project name.
    - b. Project location.
    - c. Date of completion.

- d. Department.
  - e. Department's representative and phone number.
  - f. Description and dollar value of each installed system.
  - g. Name and specific responsibility of each subcontractor or employee involved with the project.
5. For each experience project submitted, include a brief description of the system types provided and the name of the personnel directly responsible for the design (if required, and to what extent), specification, ordering, installation, programming, testing, demonstration, and overall system coordination for each of the following system types:
- a. Penetrating Fire Rated Assemblies.
  - b. Telecommunications General Requirements.
  - c. Telecommunications Cable Pathway.
  - d. Telecommunications Distribution System.
  - e. Telecommunications Grounding.
  - f. Telecommunications Identification and Labeling.
  - g. Telecommunications Testing.
- D. Personnel and Equipment:
1. Specialty subcontractors shall have direct access to all tools and test equipment required to complete the telecommunications work when the work is bid.
  2. Submit the names of the specialty subcontractor's personnel to be assigned to this project and the specific responsibility of each. If these names are not the same as the names included with the experience projects required above, submit additional experience projects to demonstrate the required experience of those to be assigned to this project on other telecommunications projects of similar size and magnitude.
  3. The specialty subcontractor's project superintendent (in office) and foreman (field) shall have five years experience at the superintendent and foreman levels, respectively, on completed telecommunications projects of like magnitude and complexity.
  4. Demonstrate and document to the extent necessary that sufficient physical and personnel resources are available to accomplish the telecommunications work of this project without endangering timely and proper completion of the work.

#### **1.11 REGULATORY REQUIREMENTS**

- A. Work shall conform to the requirements of NFPA 70 and all local amendments.
- B. Work shall conform to the requirements of all Federal, State and Local Electrical and Telecommunications Regulations.

#### **1.12 SPECIAL WARRANTY**

- A. The warranty shall extend from the date of Final Completion to the longer of twenty (20) years or the length of the Extended Warranty offered by the successful manufacturer.
- B. The warranty shall be extended to the Department via the manufacturer through a single point of contact and shall be fully backed by the manufacturer.
- C. The Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided consisting of the following:
  1. Extended Product Warranty - The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568-B and ISO/IEC IS 11801-B, exceed the attenuation and NEXT requirements of ISO/IEC IS 11801-B for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of ISO/IEC IS 11801-B for links/channels. The warranty shall apply to all passive Telecommunication Distribution System (TDS) components.
  2. System Assurance - The System Assurance shall cover the failure of the wiring system to support existing applications, as well as additional application(s) introduced in the future

- by recognized standards or user forums that use the ANSI/TIA/EIA 568-B or ISO/IEC IS 11801-B component and link/channel specifications for cabling.
3. Communications system components shall be rated for end-to-end system Category 6A, or greater performance levels on all pair combinations and warranted to support any existing or future applications which are designed to operate over a 4 connector, 500MHz, 100 meter horizontal channel (as defined in ANSI/TIA/EIA 568-B.2.1), to include support of the following applications. Performance shall be guaranteed under the Special Warranty at 100 meters (328 feet):
    - a. IEEE 802.3an 10GBASE-T
    - b. IEEE 802.3 10Base-T, 100Base-TX and 100Base-T4.
    - c. IEEE 802.5 16 Mbps token ring.
    - d. IEEE 802.12 Demand Priority Access Control.
    - e. Asynchronous Transfer Mode (ATM) data transmission at 155 Mbps.
    - f. IEEE 802.3ab 1000Base-T.
    - g. ANSI/TIA/EIA-854-2001 "A Full Duplex Ethernet Specification For 1000Mbps (1000base-TX) Operating Over Category 6 Balanced Twisted-Pair Cabling".
    - h. Future applications that become certified under the applicable standards as noted above.
  4. Extended Product Warranty - The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).
    - a. In the event this specialty subcontractor is unable to perform, goes out of business or ceases to exist, the manufacturer shall be responsible for identifying a new Contractor to assume the warranty work.
    - b. Manufacturers shall bear full responsibility for the work of their certified installer, including all aspects of the design and installation.
    - c. In the event this specialty subcontractor fails to provide satisfactory warranty support, the manufacturer shall be responsible for taking all necessary remedial steps including finding a new Contractor to provide warranty work.
  5. System Certification - Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- D. Submit a summary of the warranty highlighting major features. Clearly disclose all exceptions to the requirements of this document, and specifically indicate any and all provisions that could potentially void the warranty or reduce its benefit to the Department.
- E. Warranty programs approved as meeting the specified warranty are listed below. Final approval is subject to review and approval of the warranty:
1. Commscope Systemax Program.

### 1.13 MANUFACTURERS' RECOMMENDATIONS

- A. Installation procedures shall be in accordance with the recommendations of the manufacturer of the material being installed. Printed copies of these recommendations shall be submitted to the Department 30 days prior to installation. Installation of the item shall not proceed until the recommendations are received and approved by the Department. A copy of the recommendations shall be kept at the job site.

### 1.14 TERMINOLOGY

- A. "TDS" shall refer to the Telecommunication Distribution System cabling and hardware infrastructure internal and external to a building or buildings used to transmit voice, video and data, etc.
- B. "Stations" shall refer to individual telephone or computers, or remote peripherals of those systems (e.g., printers, facsimile machines, modems, etc).

- C. "Outlets" shall refer to the group of receptacles or jacks at the location where the stations connect.
- D. "Jacks" or "Ports" shall refer to the individual receptacles where phones, computers, etc. connect.
- E. "Station Cables" shall refer to the horizontal cables connecting patch panels or terminal blocks in the Telecommunications Rooms to the stations.
- F. "Pathways" shall refer to conduits, sleeves, cable-trays, distribution rings, etc., which are employed to route backbone and stations cables between equipment rooms, telecommunications rooms, stations, outlets, etc.
- G. "Backbone Cables", "Riser Cables" or "Tie Cables" shall refer to copper cables 25-pair or more and optical fiber cables 6-strand or more, connecting main cross-connect facilities, intermediate cross-connect facilities and telecommunications rooms. These cables may include outside plant cables between buildings and riser cables between floors.
- H. "Equipment Rooms" (ER) or "Communication Equipment Rooms" (CER) shall refer to a special-purpose room that provides space and maintains a suitable operating environment for large communications and/or computer equipment. Main rooms may also be referred to as an MDF.
- I. "Telecommunications Rooms (TR)" shall refer to a floor-serving facility for housing telecommunications equipment, cable terminations and cross-connect wiring. This is the point at which station cables terminate. It may also be referred to as an IDF.
- J. "Terminal Blocks" shall refer to multiple punch down cable terminations.
- K. "Patch Panels" shall refer to rack or frame mounted multiple punch down cable terminations with RJ-45 style, 8P8C jacks on the face for "plug and play" cross connect capability.
- L. "Cable Management" shall refer to rings, troughs, gutters etc., mounted in conjunction with telecommunications distribution equipment and terminal blocks, for the orderly routing of cables, patch cords, etc.
- M. "LEC" shall refer to the Local Exchange Carrier providing telephone service to the facility.

### **1.15 STORAGE AND HANDLING**

- A. Care shall be exercised in handling materials during construction. Damaged materials shall be repaired or replaced as directed by the Department.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. Materials shall be as specified, first quality, manufacturer's current production.
- B. The Basis of Design for copper cabling, connecting hardware, and related hardware in this section is CommScope Systimax hardware with CommScope Systimax cable as standards for quality and performance. Manufacturers other than those listed in this section will be rejected without review.
- C. There are no approved alternate cabling products for this Project.
- D. There are no approved alternate connecting hardware products for this Project.
- E. Products shall provide the standard of performance required under paragraph 1.1 and the Special Warranty above.

### **2.2 EQUIPMENT ROOMS**

- A. Termination Backboards:
  - 1. Material: Type AC fire retardant plywood. Mount the plywood with the 'A' side exposed.
  - 2. Size: 3/4 inch to cover walls as shown on drawings to a height of 8'-0" AFF.

3. Manufacturer: Hoover Pyro-Guard or as approved. Special order may be required to obtain AC grade plywood.
  4. Finish: Two coats, flat latex, intumescent fire retardant paint, Flame Control Coatings No. 20-20A, or as approved. Paint plywood on all sides and edges prior to mounting on walls.
- B. Flooring:
1. Provide anti-static tile floor in accordance with the Architectural Drawings and Specifications.
  2. Provide grounding connection to each static dissipative flooring system in two locations, in accordance with manufacturer's instructions. Grounding connections shall be homerun to the TGB or the TMGB using a #6 AWG Green THHN stranded wire.

### 2.3 SEISMIC BRACING

- A. Freestanding equipment racks shall be seismically braced in accordance with requirements of the IBC and as required by Section 26 05 29 - Hangers and Supports, of these Specifications. Seismic bracing shall consist of rigid supports. Cables, wires, chains or other non-rigid materials shall not be used for seismic support. Provide approved fixed equipment anchorage assemblies as published by the manufacturer. In lieu of manufacturer's published seismic bracing assemblies, the Contractor shall provide seismic installations approved by a licensed structural engineer.
- B. Approved drawings of seismic assemblies shall be made available for review by the Department or the inspecting Authority Having Jurisdiction upon request.
- C. Coordinate the following sections describing equipment racks and cabinets with the fiber specification section (27 20 20 - Telecom Optical Fiber Distribution).

### 2.4 FREE-STANDING EQUIPMENT CABINETS

- A. Where specified or shown on the Drawings, provide full height 19 inch wide 42 inch deep NEMA standard cabinet mount enclosure with the following features:
  1. Interior vertical cable management channels with front mounted cable management rings.
  2. Releasable hook and loop (Velcro™) cable support straps.
  3. Top, bottom, and side panels.
  4. Top panel shall have provisions for two openings for optional 4 inch standard fans.
  5. Top mounted, 4-inch cooling fans.
  6. Rack assembly shall fit within 24 inches by 42.3 inches floor area.
  7. Material and Finish: Steel with black powder-coat painted finish.
  8. Electrically isolated 0.125 inch by 1 inch by 66 inches chassis ground bus bar on the right rear side of the rack, bonded to the chassis with #6 braided by 6 inches long bonding jumpers.
  9. Equipment: Dell PowerEdge 4220, 24 inch wide by 42 inch deep cabinet or as approved.

### 2.5 RACK MOUNTED POWER DISTRIBUTION UNITS (PDU)

- A. For each telecommunication cabinet provided under this Contract in accordance with the Drawings and these Specifications provide cabinet or rack mounted Power Distribution Units per the following:
  1. Parking Level Telecom Room:
    - a. One (1) each, 120V, 20A, 1 phase - Chatsworth NEMA L5-20P, CPI 35642-2B1
  2. First Floor Plan Telecom Room:
    - a. One (1) each, 120V, 20A, 1 phase - Chatsworth NEMA L5-20P, CPI 35642-2B1
  3. Second Floor Plan Telecom Room:

- a. Two (2) each, 208Y/120V, 20A, 3 phase - Chatsworth NEMA L21-20P, CPI 35632-3A4
- b. Two (2) each, 120V, 20A, 1 phase - Chatsworth NEMA L5-20P, CPI 35642-2B1

## 2.6 CABLE MANAGEMENT

- A. Backboard mounted cable management:
  1. Distribution rings installed in communication rooms shall be "D" ring type. No bridle rings are permitted.
  2. Distribution rings shall be sized according the number and size of cables to be supported plus 50% spare capacity.
  3. Vertical trough-type cable management shall be minimum 6 inch wide, cable management trough, 110 Vertical Cable Management trough, or as approved.
  4. Horizontal trough-type cable management shall be minimum 3-1/2 inch wide, cable management trough, 110 Horizontal Cable Management trough, or as approved.
- B. Rack mounted cable management:
  1. Distribution rings shall be sized according the number and size of cables to be supported plus 50% spare capacity.
  2. Distribution rings installed in communication rooms shall be "D" ring type. No bridle rings are permitted.
  3. Vertical trough-type cable management for use with standard 7 foot equipment rack, shall be minimum 4 inches deep.
  4. Horizontal trough-type cable management shall be 3-1/2 inch wide with horizontal and vertical routing rings, with 2 inches by 1.5 inch cutouts for through cable routing.

## 2.7 IDC TERMINAL MODULES

- A. Connecting blocks shall match cables punched down under block, i.e., 5-pair for 5-pair color scheme, 4-pair for 4-pair cable, 3-pair for 3-pair cable, etc. When six pair are used 2-3 pair connecting blocks shall be used. For 25-pair or larger, use the 5-pair for 5-pair color scheme. Hardware shall be rated for ANSI/TIA/EIA 568-B Category 6A ratings and installed in accordance with ANSI/TIA/EIA 568-B guidelines. Blocks shall be color coded according to drawings and documented in accordance with ANSI/TIA/EIA 606-A. Blocks shall be identified using clear label holders and labels. Blocks shall be UL Listed.
- B. Insulation Displacement Terminal Modules: Termination blocks shall be modular and scalable up to 500 pair termination assemblies. Provide a retaining trough between every column of termination blocks.
- C. Terminal Modules shall be Type 110 mounting blocks and associated parts and shall support the system Category of the permanent channel hardware installed.
- D. Building entrance protection terminals shall be UL listed, 100 pair building entrance protector modules with 300 to 600 volt solid state protectors in accordance with NEC 800-30 for Fuseless and Fused Protectors.
  1. Protector to have 26 AWG fusible link conductor swivel cable.
  2. Protector shall have 100 Connecting Blocks.
  3. Single pair protectors shall be solid state units.
  4. Fill all modules with protectors.

## 2.8 PATCH PANELS

- A. Patch Panels: Modular jack panels shall be in 24 or 48 port configurations as shown on the Drawings. Modular jack panels installations shall contain a retaining trough between every panel. Modular Jack Panels shall be wired for T568B configuration.
- B. The terminations shall have the following characteristics:
  1. Wire Insulation Supported:

- a. Size: 0.05 inches Diameter Over Dielectric maximum for top of connecting block  
0.07 inches Diameter Over Dielectric maximum for bottom of connecting block
- b. Types: Plastic insulants (including PVC, irradiated PVC, Polyethylene, Polypropylene, PTFE Polyurethane, Nylon, Teflon)
- c. Termination Type: Insulation displacement, dry, gas tight
2. Wire Size Supported:
  - a. Solid Wire Ranges: 22-26 AWG, Re-termination >200
  - b. Stranded (7 Strands) Wire Ranges: 22-26 AWG, Re-termination: >200
  - c. Wire Insertion force (24 AWG): 13-28 lb. (59-127 Newtons)
  - d. Wire pullout force (24 AWG): 2.2 lb. (9.7 Newtons)
  - e. Wire retention force (24 AWG): Horizontal 8 lb., Vertical 2 lb.
3. Electrical Specifications:
  - a. Meet or exceed performance defined by ANSI/TIA/EIA-568-B.2, for Category 6A component, link and channel performance.
  - b. UL Listed.
- C. Designation labels for each jack shall be provided for front/rear labeling of each patch panel. Cables shall be terminated in numerical sequence and labeled as to outlet number and jack position (A, B, C, D). Provide color-coded inserts ("icons") for all jacks at patch panels and at each outlet.
- D. Equipment:
  1. Category 6A: Standard Density Modular Patch Panels.
  2. ISO 9001 Certified Manufacturer.
  3. Equipment: CommScope Systimax 360 GigaSPEED X10D 1100GS6 Evolve Category 6A UTP Patch Panel, 48 Port

## 2.9 INFORMATION OUTLETS/JACKS

- A. Outlet Requirements:
  1. Configure single gang outlet information outlets in single, duplex, triplex, quad-plex, or six-plex jack arrangement, as indicated on the Drawings.
  2. Provide outlet faceplates with both top and bottom labeling positions.
  3. Provided blank module inserts for unused module locations. Number of jack modules as shown on the Drawings.
  4. Provide full set of color coded snap-in icons for workstation outlets for use by DEPARTMENT to mark jacks for analog and digital telephones, two unique classes of data, etc. Store icons in clear plastic bags in each MTR/TR.
  5. Equipment: Wall Outlets shall be Commscope Systimax M14-SP-L with label inserts., four outlet, single gang, faceplates.
- B. Jack Requirements:
  1. Jacks for Voice and Data:
    - a. Communications jacks shall consist of multi-position 8-pin modular (8P8C) jacks, utilizing T568B termination style.
  2. Category 6A Jacks:
    - a. Jacks shall be manufactured by the same manufacturer as the modular patch panels.
    - b. Jacks shall conform to ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section and shall meet or exceed the following electrical and mechanical specifications:
      - 1). Electrical Specifications: Jacks shall meet or exceed performance specifications for the Channel as defined by ANSI/TIA/EIA-568-B.
      - 2). Mechanical Specifications:
        - a) Plug Insertion Life: 750 insertions.
        - b) Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.

- c) Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
- 3). Temperature Range: -40° to 150°F (-40° to 66°C).
- 4). Comply with FCC Part 68.
- 5). ISO 9001 Certified Manufacturer.
- 6). Equipment: CommScope X10D, MGS600 Series Category 6A UTP jack.

**2.10 PATCH CORDS**

- A. Provide Commscope Systimax factory assembled Category 6A Modular Patch Cords for each assigned port on the patch panel. Cords shall conform to the requirements of ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard, Horizontal Cabling Section, and be part of the UL LAN Certification and Follow-up Program. Cords shall be equipped with an 8 pin modular connector on each end and the minimum length patch cord shall be provided in each instance, to make an orderly, manageable connection between the patch panels or equipment being cross-connected.
- B. Provide factory assembled Category 6A Modular Patch Cords for each terminated port on the patch panel in the following quantities.

5 foot:	50% of Total
7 foot:	50% of total

- C. Unless shown otherwise on the Drawings at each location, provide spare Patch Cords of each length and type in each telecommunications room, with blue identified for data and natural for voice patching.

5 foot:	10
7 foot:	10
10 foot:	5
15 foot:	5

- D. Patch cords shall be round, and consist of 24-AWG copper, stranded conductors, tightly twisted into individual pairs.
- E. Patch cords shall be manufactured by the manufacturer of the patch panels and jacks and meet or exceed the Channel performance defined by ANSI/TIA/EIA-568-B.
- F. UL or ETL Verified for ANSI/TIA/EIA 568-B Electrical Performance.
- G. The patch cord shall have exclusion features to prevent accidental polarity reversals and split pairs.
- H. UL Listed for Fire Safety.
- I. ISO 9001 Certified Manufacturer.
- J. FCC Compliant.
- K. Provide Patch Cord storage boxes for spare patch cords provided in each TR.

**2.11 HORIZONTAL CABLES**

- A. General:
  - 1. Data cables shall be extended between the station location and its associated TR and shall consist of 4 pair, 24 gauge, UTP, and shall be terminated on the 8 pin modular jacks

- provided at each outlet. Cable jacket shall comply with Article 800 NEC for use as a plenum cable. The 4 pair UTP cable shall be UL Listed Type CMP (plenum).
2. Where conduit is run below slab-on-grade, the cable jacket shall be wet location rated. Provide cables with four FEP insulated conductor pairs (4/0 configuration).
  3. Category 6A UTP, 4 Pair.
  4. Cables shall conform to the ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section, and be part of the UL LAN Certification and Follow-up Program.
  5. Electrical Specifications:
    - a. DC resistance:  $28.6 \Omega/1,000 \text{ ft}$  ( $9.38 \Omega/100 \text{ m}$ ), maximum.
    - b. DC resistance unbalance: 5%, maximum.
    - c. Mutual capacitance @ 1 MHz: maximum pF/ft: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.
    - d. Delay skew: ns/100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.
    - e. Worst pair attenuation, dB/100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.
    - f. NEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.2.
    - g. PSNEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.2.
    - h. ELFEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.2.
    - i. PSELFEXT, dB at 100m [328 ft.]: meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.2.
    - j. Worst Pair Structural Return Loss (SRL), dB at 100m (328 ft.): meet or exceed the performance values specified in ANSI/TIA/EIA-568-B.2.
  6. Cables shall meet or exceed Category 6A performance specifications for the Channel as defined by ANSI/TIA/EIA-568-B.2.
  7. Environmental:
    - a. Storage temperature: 68° F to 122° F (20° C to 50° C).
    - b. Installation Temperature: 32° F to 122° F (0° C to 50° C).
    - c. Operating Temperature: 14° F to 140° F (-10° C to 60°).
  8. UL or ETL Verified for Category 6A Electrical Performance.
  9. UL Listed for Fire Safety.
  10. ISO 9001 Certified Manufacturer.
  11. Equipment: Commscope GigaSPEED X10D – 1091.

## 2.12 RISER CABLES

- A. Shielded or unshielded 24 AWG multi-pair copper cables shall be used as the vertical riser cables. The cable shall support voice, data and building service applications. The bending radius and pulling strength requirements of backbone cables shall be observed during handling and installation. The multi-pair copper cables shall be in non-plenum form and placed in conduit as required.
- B. The shielded non-plenum cable shall consist of solid-copper conductors insulated with expanded polyethylene covered by a PVC skin, be conformance tested to meet ANSI/TIA/EIA 568-B for Category 3 cables, be UL Listed as CMR. The core shall be overlaid with a corrugated aluminum sheath, which is adhesively bonded to an outer jacket of PVC plastic to form a protective sheath. The copper riser cable shall meet or exceed the following electrical specifications listed below:
  1. Electrical Specifications:
    - a. Average DC Resistance:  $26.5\Omega/1,000 \text{ ft}$  ( $8.7\Omega/100\text{m}$ ), maximum.
    - b. Average DC Resistance Unbalance: 1.7%, maximum.
    - c. Mutual Capacitance @ 1 MHz:  $16 \text{ nF}/1000 \text{ ft}$  ( $5.25 \text{ nF}/100 \text{ m}$ ), maximum.

- d. Capacitance Unbalance (pair to ground): 201pF/1,000 ft (65.94 pF/100m) maximum.
- e. Attenuation (dB/100 m [328 ft.]):

Frequency	Attenuation (Max.)
1.00 MHz	2.2 dB
4.00 MHz	5.6 dB
10.00 MHz	9.7 dB
16.00 MHz	13.1 dB

- f. Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

Frequency	Pair-To-Pair
1.0 MHz	41 dB
4.0 MHz	32 dB
10.0 MHz	26 dB
16.0 MHz	23 dB

- g. The PVC sheath shall have improved frictional properties, allowing it to be pulled through conduit without the use of lubricants.
  - h. The cable shall be available in 25, 50, 100, 200, and 300 pair counts.
  - i. UL Listed for Fire Safety.
  - j. ISO 9001 Certified Manufacturer.
- C. The non-shielded non-plenum cable shall consist of 24-AWG solid-copper conductors insulated with color coded PVC, 25 pair cable shall be UL Verified to ANSI/TIA/EIA 568-B for Category 3, 25 to 100 pair shall be conformance tested to meet ANSI/TIA/EIA 568-B for Category 3 cables. The cable shall be available in 25, 50, 75 and 100 pair. The copper cable shall meet or exceed the following electrical specifications listed below:
- 1. Electrical Specifications:
    - a. Maximum DC Resistance: 28.6  $\Omega$ /1,000 ft (9.4  $\Omega$ /100m).
    - b. Maximum DC Resistance Unbalanced: 5%.
    - c. Maximum Capacitance Unbalanced (pair to ground): 1,000 pF/1000 ft. (328 pF/m).
    - d. Mutual Capacitance @ 1MHz: 18 nF/1000 ft (5.9 nF/100 m), maximum.
    - e. Attenuation (dB/100 m [328 ft.]):

Frequency	Attenuation (max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

- f. Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

Frequency	Worst Pair NEXT (min.)
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

2. UL Listed for Fire Safety.
3. ISO 9001 Certified Manufacturer.

### 2.13 LABELING

- A. Provide machine printed labels for patch panels, cables, outlets, etc., in accordance with ANSI/TIA/EIA-606-A. Provide labeling nomenclature in accordance with information on the Drawings or Department's labeling conventions. Submit labeling samples for all required applications.
- B. Machine Printed Label Requirements:
  1. PC Compatible.
  2. Can save and modify files.
  3. Fully integrated with AutoCAD.
  4. Editable Fonts and Sizes.
  5. Rotate Text and Objects.
  6. Vary Line Spacing.
  7. Ability to import graphical images.
  8. Capable for customization of layout.
  9. Re-positional labels.
- C. Basis of Design:
  1. Brady Electrical/Datacomm Worldwide (latest version of LabelMark).
  2. Cable Management Software International (latest version of docIT).
  3. Approved alternate.
- D. Labeling and color coding identification for this project shall conform to TIA/EIA-606-A for a Class 4 Administrative System.

### 2.14 UNSPECIFIED EQUIPMENT AND MATERIAL

- A. Items of equipment or material not specifically addressed on the Drawings or in this document and required to provide a complete and functional TDS installation shall be provided in a level of quality consistent with other specified items.

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### 3.2 GENERAL

- A. Provide, connect and test equipment and materials for the systems herein specified and shown on the Drawings. Wiring shall be neatly tied or laced in cabinets and terminated on

terminal strips provided for the purpose. Each cable shall be identified by an approved marking system at each end.

- B. Outlet/Jacks shall be identified with machine printed labels. Hand lettered labels shall not be used.
- C. Provide labels and color-coded inserts for each jack at patch panels, in accordance with TIA/EIA-606-A.
- D. Provide full set of snap-in icons for workstation outlets for use by Department to mark jacks for analog and digital telephones as two unique classes of data. Store icons in clear plastic bags in each IDF/MDF.
- E. Wherever materials, methods or placements of materials and equipment for the communications work is provided by other subcontractors or the Department, it shall be the responsibility of this specialty subcontractor to coordinate that work and assure that it is provided in such a manner as to enhance the final system operation.
- F. Coordinate installation of lighting, ventilation and other systems in the communication rooms to avoid interferences.
- G. Test the systems, demonstrate operation to the Department and provide training as specified.
- H. In each TR, IC, MDF, IDF and equipment room provide a minimum of a 34 inch by 24 inch CAD drawing indicating floor plan and telecommunication one-line. The floor plan shall indicate telecommunication outlets with the appropriate outlet designation indicated on the plan. Mount drawing beneath a sheet of 1/8 inch clear Plexiglas on wall. Provide marking pens attached with Velcro to facilitate marking when moves, adds, or changes occur. Plexiglass and floor plan shall be mounted in such a way as to allow easy and rapid updates to the underlying floor plan. Include all copper and optical fiber systems on this drawing.
- I. Work under this section shall be closely coordinated with work under other sections of the project.

### **3.3 COLOR CODE SYSTEM**

- A. Cables for one floor may be run in the tray system of another floor where necessary or shown, and shall be clearly identified by their unique floor-specific color. One color shall be used for all horizontal cables originating on a floor. A different color shall be used for the floor above, and another unique color for the floor below.

### **3.4 CODES AND PERMITS**

- A. Apply and pay for fees, permits, and obtain serving utility and governmental approvals.
- B. Coordinate .work with the serving utility.
- C. Raceway fill requirements for communications systems shall be in accordance with ANSI/TIA/EIA-569-A and BICSI.
- D. NEC bending radius of communications ducts, raceways, Cable Trays, etc., shall be increased to not less than the installed cable manufacturer's recommendations, and the applicable ANSI and BICSI Standards.
- E. Communications work shall be in complete accordance with the following:
  - 1. National Electrical Code (NEC), latest legally enacted edition.
  - 2. Regulations of the State Fire Marshal.
  - 3. National Fire Protection Association (NFPA) Codes.
  - 4. All state, county and local codes and ordinances.

### **3.5 DELIVERY AND STORAGE**

- A. Materials and Equipment shall be stored with protection from mechanical damage, weather, humidity and temperature variation, dirt and dust, and other contaminants.

- B. Materials shall be inspected and inventoried promptly upon receipt.
- C. Cables shall be tested immediately upon receipt and received or rejected and returned based upon testing or visual inspection.
- D. Report and record serial numbers received and/or rejected.
- E. Inspection and testing shall be performed under the observation of the Department at the Department's option. Provide three (3) working days advance notice of tests.

### 3.6 LAYOUT

- A. Work shall be laid out in advance. Shop drawings shall be submitted to the Department for approval before work begins. Maximum height for terminal blocks and patch panels shall be 6 feet-6 inches, minimum height shall be 1 feet-6 inches. Cables shall be racked and supported in a workmanlike fashion. Work shall be labeled according to ANSI/TIA/EIA 606-A, and color coded according to BICSI Standards. In the absence of details on the drawing governing the layout of terminations, the following guidelines shall apply.
  - 1. Pairs from each cable shall be terminated sequentially from left to right, top to bottom starting with the lowest assigned number at the upper left hand corner of the frame.
  - 2. Trunk or riser cables shall terminate on dedicated terminal blocks, separate from but adjacent to horizontal terminal blocks. Cross-connect or patch cords longer than 18 feet shall be avoided. Install stress relief hardware where needed.
- B. Keep up to date "As-built" record drawings at each job site detailing the layout of all data racks and telephone, data and trunk terminations, including a typed listing of cables/rooms served by each terminal block and patch panel. Refer to Section 26 00 00 - Electrical General Requirements for other Record Document requirements.
- C. Layout Shop Drawings shall be prepared using CAD. Final approved Shop Drawings shall be updated with precise "as-built" conditions and shall be submitted with the Operations and Maintenance Manuals. File format shall be AutoCAD "DWG" or "DXF."

### 3.7 CABLE INSTALLATION

- A. Cable shall be installed in conduit routed to directly to Telecommunication Rooms or via conduit stubbed to cable. The use of so called 'j-hooks' or distribution rings will not be allowed.
- B. Cable shall be installed according to the instructions set forth in the Commscope Installation and Maintenance Class as required by the Commscope Systemax Business Partner Program.
- C. If cable dimensions shown are exceeded, cable pathways and supports shall be resized to maintain the original fill ratios based on the dimensions shown.
- D. Follow cable manufacturer's specification regarding handling methods, retaining/support methods, bending radius and maximum pulling tension limitations.
- E. Telecommunication cables shall not be installed in the same raceway as power cables.
- F. Cables shall be installed in a neat and orderly manner and shall not cross or interlace other cables except at breakout points.
- G. Cables in vertical trays shall be individually retained with straps at a maximum of 6 feet on center.
- H. Tie wraps shall not deform the cable insulation when tightened.
- I. All cables shall be routed to minimize EMI and RFI interference. Cable shall be routed according to the following table. Spacings are minimum for all Category 3 and higher cable.

Minimum Separation of Telecommunications pathways  
from 480 volt or less power lines

Condition	<2 kVA	2-5 kVA	>5 kVA
Unshielded power lines or electrical equipment in proximity to telecommunications open or nonmetal pathways.	5 in	12 in	24 in
Unshielded power lines or electrical equipment in proximity to telecommunications grounded metal conduit pathways	2.5 in	6 in	12 in
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a telecommunications grounded metal conduit pathway	N/A	3 in	6 in
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to telecommunications open or nonmetal pathways.	2.5 in	6 in	12 in
Mechanical ductwork, metal floors and other metallic planes to telecommunications open or nonmetal pathways.	2 in		
Mechanical ductwork, metal floors and other metallic planes to telecommunications open or grounded metal conduit pathways.	0 in		
Fluorescent or HID Lighting Fixtures	5 in	5 in	5 in

### 3.8 LUBRICANT

- A. Pulling lubricant, shall be used to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Lubricant shall be applied to the cable sheath with a lubricator. When pulling has been completed, the exposed cable ends shall be wiped clean of lubricant.
- B. Lubricants shall be compatible with and intended for use with plastic-sheathed cables. Soap and grease type lubricants shall not be allowed.
- C. Equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cable shall be pulled without stopping until the required amount of the cable has been placed. When the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cable shall be overcome by increasing the tension in small steps a few seconds apart until the cable is in motion. Cable shall be paid from the top of the reel by rotating the reel in the feed direction at the rate of pull. Cable shall not be stripped off the reel by pulling.

### 3.9 SEAL

- A. Underground conduit or ducts in which cable is placed shall be sealed with urethane foam duct seal. This material shall be inserted between the cable and the duct and in all unused ducts, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the manhole or vault.

### **3.10 DAMAGE AND DEFECTS**

- A. For underground cables, use a tension monitoring device to ensure that the maximum pulling tension that may be applied to the cable to be pulled into a conduit section is not exceeded. Provide replacement cable if cable manufacturer's maximum pulling tension is exceeded at any time during a pull.
- B. Cable shall be carefully inspected for sheath defects or other irregularities as it is paid out from the reel. When defects are detected, pulling shall stop immediately and the cable section shall be repaired or replaced at the discretion of the Department. A system of communications shall be maintained between pulling and feed locations so that pulling can be stopped instantly, when required.
- C. For underground cables, cable shall be hand guided through intermediate manholes and into the next duct section when making pull-throughs. Proper rigging shall be used in the intermediate manhole to keep the pulling line and cable aligned with the exit duct to prevent the line or cable from rubbing against the edge of the duct. Cables in pull-through manholes shall be set up and racked before the cable ends in adjacent manholes are set up and racked.
- D. For underground cables cable ends pulled into manholes, vaults, or terminal locations that are not to be racked or otherwise permanently positioned immediately shall be tied in fixed positions to prevent damage to the cables and provide adequate working space.
- E. Adequate care shall be exercised when handling and storing reels of cable to prevent damage to the cable. Cable with dents, flat spots, or other sheath distortions shall not be installed.

### **3.11 DISTRIBUTION RINGS AND CABLE SUPPORTS**

- A. The use of so called "j-hooks" or distribution rings will not be allowed on this Project.

### **3.12 TERMINATION MODULES**

- A. Layout telephone and data terminal blocks as indicated on drawings with spacing as recommended by manufacturer.
- B. Ground metal back frames with #6 insulated copper to the Chassis Ground System (CGS). Use Cool Amp bolted connections or Cadweld connections.

### **3.13 CROSS-CONNECTIONS**

- A. Cross-Connections at and/or between all terminal hardware shall be provided to form a complete and functioning system.
- B. Patch Cords shall be used to make Cross-Connections.
- C. Cross-Connections from Terminal Modules color coded White to Terminal Modules color coded Blue shall be 4-pair wide and serve a single jack or termination in the horizontal distribution.

### **3.14 INTERCONNECTIONS**

- A. Interconnections at terminal hardware shall be provided to form a complete and functioning system.
- B. Equipment cables shall be interconnected to horizontal cabling on Termination Modules color coded blue.

### **3.15 EQUIPMENT RACKS**

- A. Equipment racks shall be seismically braced by securely bolting to the structural floor supplemented with additional braces as required for the Seismic Zone.
  - 1. Mount ground bars on insulating bushed standoffs.
  - 2. Connect Wiremold to power outlets.

3. Electrically separate open racks with insulating washers and nonconductive screws.
4. Electrically separate enclosed racks with insulating washers and nonconductive screws.

### 3.16 TERMINATIONS

- A. Cables shall be marked with wire markers at both ends, and terminals on terminal blocks or patch panels shall bear the cable number. Trunk cables shall be neatly marked with "From-To" information.
- B. Wire twist shall be maintained to within 0.25 inch of the termination.

### 3.17 TERMINATION MODULES

- A. Install per manufacturer's recommendations.
- B. Protection modules shall conform to NEC 800-30 and be installed per manufacturer's recommendations.

### 3.18 COMPLETION AND TESTING

- A. Telecommunications System test reports shall be submitted to and approved by the Department. The test reports shall certify that the Telecommunications Distribution System is complete, passes all test criteria, is fully operational, and that all work has been witnessed as specified.
- B. After installation and test of each system is complete, each system and the entire system shall be demonstrated and tested for proper operation. Schedule a demonstration with the following representatives present:
  1. Contractor's representative.
  2. Manufacturer's representative for each major communications subsystem.
  3. The Department's representative.
- C. Provide all forms, instrumentation and test equipment, loads, and other consumables required to demonstrate the systems to the Department's satisfaction.
- D. Incoming Inspection Tests:
  1. Inspect materials for damage.
- E. Patch Cord Testing:
  1. Patch cords shall be tested and shown to comply with the applicable Category cord requirements of TIA/EIA-568B.
  2. Compliance shall be proven by testing patch cords alone (i.e., not by inserting the patch cords into a channel).
  3. Cord performance shall be measured on-site by either using either the TIA method delineated in Annex J or by using a cord-test adapter and a hand-held LAN cable tester. Cord compliance may be demonstrated by actual test reports supplied by the patch cord manufacturer.
- F. Final Inspection Tests:
  1. Testing of copper wiring shall be performed prior to system acceptance. 100 percent of the horizontal and riser wiring pairs shall be tested. Link testing of all copper cabling shall be performed. Complete, end to end test results shall be submitted to the Department.
    - a. Category 6A cable runs shall be tested for conformance to the specifications of EIA/TIA 568-B.2, Category 6A. Testing shall be done with a ANSI/TIA/EIA 568-B ETL verified Level II-E test set, with accuracy per Proposed TIA Level III standards.
      - 1). Test shall include all requirements of ANSI/TIA/EIA 568-B, including wiremap, length, characteristic impedance, insertion loss, ambient and impulse noise, NEXT, PSNEXT, FEXT, ELFEXT, PSELFEXT, return loss, ACR, PSACR, Propagation Delay and Delay Skew.

- 2). Supported test frequency shall be 1-350 MHz to provide re-certification capability beyond Category 6 requirements.
  - 3). "Full Plot" storage shall store entire test, and be capable of uploading saved data and re-characterizing cables against new or evolving performance standards. Testers only saving worst case data are not acceptable. Test data shall be saved and provided to the Department in neatly bound hardcopy and electronic format compatible with ScopeData Pro® software. Provide a copy of the software with the data.
  - 4). Reports shall be graphic, showing test results plotted against standards. Reports shall include a pass/fail summary of all network types specified.
  - 5). Any cables not meeting the requirements of the standard shall be brought into compliance at no charge to the Department.
  - 6). Tester shall be equal to Fluke DTX CableAnalyzer, or IDEAL LANTEK 6A or Agilent PRO N2640A-100 Cat 6A tester. Category 3 cable runs shall be tested for conformance to the specifications of EIA/TIA 568-B.2, Category 3.
2. Test all cable with an approved cable tester in the presence of the Department, at the Department's option. Provide three (3) working days advance notice of tests. Record cable numbers on data test reports. Submit reports to Department.
  3. Test all cables from both ends.
  4. Re-test all cable disturbed after testing, at the direction of the Department.
  5. Spare unterminated cables shall be temporarily terminated for testing.
- G. Replace rejected materials.
- H. Test AC grounds and voltages in equipment racks.
1. Record voltage at equipment rack power source both at no load and at 15 Amp resistive load.

### 3.19 OPERATING AND MAINTENANCE MANUALS

- A. Prepare manuals describing the servicing and maintenance requirements for the equipment being provided as required in this Section of these specifications.
- B. Information contained in the manuals shall consist of catalog data on each item, together with parts lists, wiring diagrams, test reports, description of routine maintenance required, suggested frequency of maintenance and recommended practices, and shall be 8-1/2 inches by 11 inches in size. Catalog pages and data in manuals shall be neat, clean copies. Drawings shall be accordion folded to above size. An index shall be provided which shall list all contents in an orderly manner. Include corrected shop drawings in the maintenance manuals. Each copy of the instruction manual shall be adequately labeled for identification and shall include plastic tabs coordinated with the index.
- C. Provide "Step-by-step" instructions for interpreting and utilizing the cable, outlet, jack and equipment identification system, including instruction for use of jack icons.
- D. Refer to "Submittals" requirements of this Section for additional O&M requirements.

### 3.20 INSTRUCTION AND TRAINING

- A. Provide factory trained and authorized instruction in the proper operation, maintenance, and periodic test of all equipment shown on the Drawings and specified herein.
- B. Provide detailed instructions to the DEPARTMENT on how to obtain warranty service under the Special Warranty.

**END OF SECTION 27 20 10**

**SECTION 27 20 20**  
**TELECOM OPTICAL FIBER DISTRIBUTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION AND GENERAL SPECIFICATIONS**

- A. The intent of this Specification is to place in working order a complete, fully tested and documented Optical Fiber Cable Distribution system complying with the Codes and Standards referenced herein.
- B. This section describes general requirements, products and methods of execution relating to provisions for service entry, equipment space and cabinets and optical fiber cabling and connections for the telephone and data systems required for this project.
- C. Provide the equipment, materials, and labor to install and test the systems shown on the Drawings and specified herein. This shall include (but not limited to) provision of all trenching and backfill, raceways, innerducts, sleeves, boxes, gutters, shelves, enclosures, shelf and enclosure supports, backboards, equipment racks, cables, patch cords, pull ropes (in unused conduits), Fiber Distribution Units (FDUs), patch panels, outlets, jacks, splices, connections, cable management, labeling, testing and all other material, equipment, and labor required to make the systems fully operational.
- D. References in this section to "fiber" shall refer to optical fiber cable.
- E. Scope of work:
  - 1. Fiber shall be provided between fiber optic Fiber Distribution Units (FDUs). Cables shall be fully terminated or fusion spliced and systematically identified on both ends.
  - 2. Provide conduit, innerducts, cable support systems, cable management, etc., for the routing of fiber cables as shown on the Drawings.
  - 3. Perform testing of fiber strands, including all spare and unused fibers, in accordance with the requirements herein.
  - 4. Provide fiber terminations and connectors in accordance with these specifications. The connector style for this project is SC and MTRJ in the configurations noted.

**1.2 RELATED SECTIONS**

- A. 01 91 00 - Commissioning
- B. 26 05 34 - Conduit and Fittings
- C. 26 05 36 - Cable Tray
- D. 27 20 10 - Telecommunications Distribution System

**1.3 COORDINATION**

- A. The necessity to coordinate this work with the Serving Utilities and the Department is emphasized. The Contractor shall be responsible for any omissions, delays and additional cost due to lack of coordination.
- B. Coordinate work with other trades. Layout of cables to maintain minimum clearances shall be coordinated with all trades for new and existing work. Report all conflicts to the Department.
- C. Downtime for existing systems shall be minimized. It is the responsibility of the Contractor to plan, coordinate, and execute installation activities so that production networks and communication circuits are not unduly interrupted. Periods of unavoidable interruption must be less than 4 hours in duration.

**1.4 REFERENCE CODES AND STANDARDS**

- A. The publications listed below form a part of this section to the extent referenced. The edition current at the time of bid (with all applicable addenda) shall apply:

REFERENCE	TITLE/REVISION
ANSI/EIA/TIA- 455-B	STANDARD TEST PROCEDURES FOR FIBER OPTIC FIBERS, CABLES AND TRANSDUCERS, SENSORS, CONNECTING AND TERMINATING DEVICES AND OTHER FIBER OPTIC COMPONENTS
ANSI/TIA/EIA-526-7	MEASUREMENT OF OPTICAL POWER LOSS OF INSTALLED SINGLE-MODE FIBER CABLE PLANT
ANSI/TIA/EIA-526-14A	OPTICAL POWER LOSS MEASUREMENTS OF INSTALLED MULTI-MODE FIBER CABLE PLANT
ANSI/TIA-492AAAA-A	DETAIL SPEC. FOR 62.5/125 MULTI-MODE, GRADED INDEX OPTICAL FIBERS
ANSI/TIA-492AAAB	DETAIL SPEC. FOR 50/125 MULTI-MODE, GRADED INDEX OPTICAL FIBERS
ANSI/TIA-492CAAA	DETAIL SPEC. FOR CLASS 4A DISPERSION-UNSHIFTED SINGLE-MODE OPTICAL FIBERS
ANSI/ICEA S-83-596	FIBER OPTIC PREMISES DISTRIBUTION CABLE
ANSI/ICEA S-87-640	FIBER OPTIC OUTSIDE PLANT COMMUNICATION CABLE
ANSI/ ICEA S-104-696	INDOOR-OUTDOOR OPTICAL FIBER CABLE
ANSI/TIA/EIA-568-B	COMMERCIAL BUILDING TELECOMMUNICATION CABLING STANDARD
ANSI/TIA/EIA-569-A	COMMERCIAL BUILDING STANDARD FOR TELECOMMUNICATIONS PATHWAYS AND SPACES
ANSI/TIA/EIA-598-A	OPTICAL FIBER CABLE COLOR CODING
ANSI/TIA/EIA-606-A	ADMINISTRATION STANDARD FOR COMMERCIAL TELECOMMUNICATIONS INFRASTRUCTURE
ANSI/TIA/EIA-607	COMMERCIAL BUILDING Grounding AND BONDING REQUIREMENTS FOR TELECOMMUNICATIONS
ANSI/TIA/EIA-758	CUSTOMER-OWNED OUTSIDE PLANT TELECOMMUNICATIONS CABLING STANDARD
ANSI/TIA/EIA-758-1	ADDENDUM TO ANSI/TIA/EIA-758
ANSI Z136.2	AMERICAN STANDARD FOR THE SAFE OPERATION OF OPTICAL FIBER COMMUNICATION SYSTEMS UTILIZING LASER DIODE AND LED SOURCES
BICSI	TELECOMMUNICATIONS DISTRIBUTION METHODS MANUAL

### 1.5 UL COMPLIANCE

- A. Where a UL listing or classification exists for a product and the product is suitable for the purpose specified and indicated the product shall:
  - 1. Bear the UL marking indicating listing or classification.
- B. Where a UL Standard is in effect, equipment shall:
  - 1. Meet that Standard.
  - 2. Bear the UL Label.

## 1.6 QUALIFICATIONS

- A. The telecommunications work specified in this Section is acknowledged to require special skills mastered by education, experience, or both. Bidders for telecommunications work described in this Section shall be specialty telecommunications Contractors, who may be a subcontractor of the Electrical Contractor.
- B. Specialty subcontractors bidding telecommunications work shall have a minimum of five (5) years experience in the construction, testing, and servicing of systems of the type and magnitude specified herein. This Subcontractor shall have completed at least three projects equal or larger in size than this project within the past five (5) years. The Subcontractor shall have direct access to all tools and test equipment required to complete the telecommunications work at the time of the bid. At least three comparable or larger experience projects and a list of the tools and test equipment (indicating Department ship) expected to be used shall be submitted within 30 days of project award to demonstrate these experience and access requirements. Experience projects shall have been completed within the last five (5) years. For each project, include a brief description of the system types provided and the names of the personnel directly responsible for the design (if required, and to what extent), specification, ordering, installation, programming, testing, demonstration, and overall system coordination for each of the following system types:
  1. Fiber Optic Cable Installation.
  2. Fiber Optic Terminating and Splicing.
  3. Fiber Optic Identification and Labeling.
  4. Fiber Optic Testing.
- C. For each of the experience projects submitted, provide the following information:
  1. Name of the project.
  2. Project location.
  3. Date of completion.
  4. The Contracting Agency.
  5. The Contracting Agency's representative and phone number.
  6. Description and dollar value of each installed system.
  7. Name and specific responsibility of each subcontractor or employee involved with the project.
- D. Provide the names of the Contractor's personnel to be assigned to this project and the specific responsibility of each. If these names are not the same as the names included with the experience projects required above, submit additional experience projects to demonstrate the experience of those to be assigned to this project on other Telecommunications projects of similar size, magnitude and complexity. Fiber optic cable splices, terminations and testing shall be made by journeymen cable splicers who have had a minimum of 3 years of individual experience in splicing and terminating fiber optic cables. Each person who is to perform fiber optic cable splicing shall perform a minimum of one acceptable sample splice and termination. Sample splices and terminations shall not be incorporated in the job.
- E. The Telecommunications subcontractor's project superintendent (in office) and foreman (field) shall have five years experience at the superintendent and foreman levels, respectively, on completed telecommunications projects of like magnitude and complexity.
- F. Demonstrate and document to the extent necessary that sufficient physical and personnel resources are available to accomplish the communications work of this project without endangering timely and proper completion of the work.
- G. Qualifications of Testing Personnel: Submit the qualifications of testing personnel to the Department for approval 30 days prior to testing. A complete instruction course outline including the contract requirements, specifications and Drawings plus the certification of the qualifications of the instructors shall be submitted to the Department for approval no later than 30 days after the award of the bid.

- H. Test Record Format: Submit a Contractor developed format for recording test data for approval by the Department as part of the test plan.
- I. Qualifications of Splicers: Submit the Qualifications of Splicers to the Department for approval and with adequate time to be approved 30 days prior to installation. A complete instruction course outline including the contract requirements, specifications and Drawings plus the certification of the Qualifications of the Instructors shall be submitted to the Department for approval no later than 30 days after the award of the bid. When the Contractor deems it necessary to deviate from the splices shown on the Drawings, the Contractor shall submit justification and the proposed splicing techniques to the Department for approval. Splices, if approved, shall be provided at no additional cost to the Department.
- J. Provide a signed statement indicating that the telecommunications systems subcontractor has the ability to provide the service required elsewhere herein by factory trained and qualified technicians for each major system type and will continue to maintain that capability until the end of the guarantee period.

### 1.7 SUBMITTALS

- A. Submit the following in accordance with Specification Section 26 00 00 - Electrical General Requirements - "Submittals," and Division 1 in sufficient detail to show full compliance with the Specifications:
  - 1. Qualification Requirements as noted in this section and Division 1 - Minimum Qualification Requirements.
  - 2. Manufacturer's Catalog Data shall be submitted for items as described in Part 2 of this Specification Section. Data shall include a complete list of parts, special tools, and supplies with current unit prices and source of supply.
  - 3. Factory Test Data: Submit factory test reports for all fiber optic cable shipped. All fiber strands shall be factory terminated and tested prior to shipping. Fiber shall be shipped with factory terminations intact for re-testing upon receipt in accordance with testing requirements herein.
  - 4. Manufacturer's Installation Procedures: Printed copies of the manufacturer's recommended installation procedures shall be submitted to the Department 30 days prior to installation, in accordance with the requirements herein.
  - 5. Shop Drawings: Submit Shop Drawings for approval by the Department as follows:
    - a. Dimensioned routing of conduits and innerducts for fiber optic cables as provided under Specification Section 26 05 34 - Conduit and Fittings and indicated on the Drawings. Dimensioned layouts for existing conduit systems are not required.
    - b. Dimensioned rack plan layouts for all fiber optic termination equipment in all telecommunication rooms.
    - c. Dimensioned rack elevation layouts for all fiber optic termination equipment in all telecommunication rooms.
- B. Labeling System: Coordinate with the Department for the Department's labeling conventions. Submit Project labeling system for approval.
- C. Quality Control Plan: Contractor shall prepare a Quality Control plan which provides a detailed outline of all testing to be accomplished. The Quality Control plan shall include, as a minimum, a schedule of when tests will be performed relative to installation milestones, specific test procedures that will be used, a list of test equipment that will be used including manufacturer, model number, calibration certification, range and resolution accuracy. Test plan shall be submitted to the Department for approval at least 30 days prior to the start of testing.

### 1.8 SPECIAL WARRANTY

- A. The warranty shall extend from the date of final completion to the longer of fifteen (15) years or the length of the standard warranty offered by the successful manufacturer.

- B. The warranty shall be extended to the Department via the manufacturer through a single point of contact and shall be fully backed by the manufacturer.
- C. The Extended Product Warranty and System Assurance Warranty for this wiring system shall be provided consisting of the following:
  - 1. The Extended Product Warranty shall ensure against product defects, that all approved cabling components exceed the specifications of ANSI/TIA/EIA 568-B and ISO/IEC IS 11801-B, exceed the attenuation requirements of ISO/IEC IS 11801-B for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of ISO/IEC IS 11801-B for links/channels. The warranty shall apply to all passive Telecommunication Distribution System (TDS) components.
  - 2. The System Assurance shall cover the failure of the wiring system to support any existing application, as well as additional application(s) introduced in the future by recognized standards or user forums that use the ANSI/TIA/EIA 568-B or ISO/IEC IS 11801-B component and link/channel specifications for cabling.
    - a. FDDI.
    - b. IEEE 802.3z 1000Base-SX, 1000Base-LX.
    - c. IEEE 802.3 10GBASE-X
    - d. 1000Base-LX over fiber optimized for 10GBASE-X.
    - e. Future application certified under the applicable standards as noted above.
  - 3. The Extended Product Warranty and the System Assurance shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s).
    - a. In the event this specialty subcontractor is unable to perform, fails to provide satisfactory support, goes out of business, or ceases to exist the manufacturer shall be responsible for taking all necessary remedial steps including identifying a new CONTRACTOR to provide the warranty work.
    - b. Manufacturers shall bear full responsibility for the work of their certified installer, including all aspects of the design and installation.
  - 4. Upon successful completion of the installation and subsequent inspection, the customer shall be provided with a numbered certificate, from the manufacturing company, registering the installation.
- D. Submit a summary of the warranty, highlighting all major features. Clearly disclose all exceptions to the requirements of this document, and specifically indicate any and all provisions which could potentially void the warranty or reduce its benefit to the Department.
- E. Warranty programs approved as meeting the specified warranty are listed below. Final approval is subject to review and approval of the warranty.
  - 1. Commscope Systemax Program.
- F. Provide summary of warranty highlighting major features. Clearly disclose all exceptions to the requirements of this document, and specifically indicate any and all provisions which could potentially void the warranty or reduce its benefit to the Department.

### **1.9 REGULATORY REQUIREMENTS**

- A. All Work shall conform to the requirements of NFPA 70.
- B. All Work shall conform to all requirements of Federal, State and Local Electrical and Telecommunications Regulations.

### **1.10 MANUFACTURERS' RECOMMENDATIONS**

- A. All installation procedures shall be in accordance with the recommendations of the manufacturer of the material being installed. Printed copies of these recommendations shall be submitted to the Department 30 days prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received and approved by the Department. A copy of the recommendations shall be kept at the job site.

### 1.11 TERMINOLOGY

- A. References in this section to "fiber" shall refer to optical fiber cable.
- B. "Composite" - Copper conductors and fibers within a single jacket.
- C. "Hybrid" - Single-mode and multi-mode fibers within a single cable jacket.
- D. "TDS" shall refer to the Telecommunication Distribution System cabling and hardware infrastructure internal and external to a building or buildings used to transmit voice, data, etc.
- E. "Stations" shall refer to individual telephone or computers, or remote peripherals of those systems (e.g.: printers, facsimile machines, modems, etc.).
- F. "Outlets" shall refer to the group of receptacles or jacks at the location where the stations connect.
- G. "Jacks" or "Ports" shall refer to the individual receptacles where phones, computers, etc. connect.
- H. "Station Cables" shall refer to the horizontal cables connecting patch panels or terminal blocks in the Telecommunications Rooms to the stations.
- I. "Pathways" shall refer to conduits, sleeves, Cable Trays, distribution rings, etc., which are employed to route backbone and stations cables between equipment rooms, telecommunications rooms, stations, outlets, etc.
- J. "Backbone Cables", "Riser Cables" or "Tie Cables" shall refer to optical fiber cables 6-strand or more, connecting main cross-connect facilities, intermediate cross-connect facilities and telecommunications rooms. These cables may include outside plant cables between buildings and riser cables between floors.
- K. "Equipment Rooms" (ER) or "Communication Equipment Rooms" (CER) shall refer to a special-purpose room that provides space and maintains a suitable operating environment for large communications and/or computer equipment. These rooms may contain main cross-connect or intermediate cross-connect facilities, MUXs, PBXs and building entrance facilities from the local exchange carrier (LEC). Main rooms may also be referred to as a MDF.
- L. "Telecommunications Room (TR)" shall refer to a floor-serving facility for housing telecommunications equipment, cable terminations and cross-connect wiring. This shall be the point at which station cables terminate. It may also be referred to as an IDF.
- M. "Patch Panels" shall refer to rack or frame mounted multiple cable terminations with the type of connectors as specified herein.
- N. "Cable Management" shall refer to rings, troughs, gutters etc., mounted in conjunction with telecommunications distribution equipment and terminal blocks, for the orderly routing of cables, patch cords, etc.

### 1.12 STORAGE AND HANDLING

- A. Care shall be exercised in handling materials during construction. Damage shall be repaired or replaced as directed by the Department.
- B. Test all fiber upon receipt and store properly until installed. Immediately replace all fibers that are damaged upon receipt.
- C. Immediately report any visible damage to shipped products to the shipper, the manufacturer, and the Department.

### 1.13 TELECOMMUNICATION SERVICE TO THE EXISTING MUSEUM

- A. The existing museum is currently served with a 12 strand singlemode fiber optic cable. Coordinate with the Department and pull back this existing fiber optic cable to the serving utility manhole/pull box located on the east side of Whittier Street and properly store for extension into the new Library, Museum, Archive building under this Contract. Provide fiber optic splice case and fusion splice 12 strand singlemode fiber optic cable to the existing cable

as required to extend into the new Main Telecom Room via new pathway provided under this Contract.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. All materials shall be as specified, first quality, manufacturer's current production.
- B. Where conduit is run below slab-on-grade, the fiber optic cable jacket shall be wet location rated.
- C. The Basis of Design for optical fiber cabling, connecting hardware, and related hardware in this section is Commscope Systimax cable and related hardware as standards for quality and performance. No substitutions will be permitted.

### **2.2 EQUIPMENT RACKS AND CABINETS**

- A. Provide equipment racks and cabinets in accordance with Specification Section 27 20 10.

### **2.3 FIBER OPTIC CABLE CONNECTORS**

- A. Provide field installable multi-mode (MM) or single-mode (SM) connectors to terminate fiber optic cables from cable-to-cable, cable-to-equipment or equipment-to-equipment, and to make jumpers.
- B. The connector shall be capable of mounting on either 0.9 mm buffered fiber or on 3.0 mm cordage and utilize a PC polishing on the tip to provide high yield during installation. All connectors shall have ceramic ferrules, meet EIA and IEC standards for repeatability and have a locking feature to the coupler and assure non-optical disconnect.
- C. This project shall use type Duplex SC and LC connectors, unless otherwise noted. These connectors shall meet the following criteria:
  - 1. SC Connector Specifications:
    - a. Typical Insertion Loss: 0.30 Db.
    - b. Return Loss: better than -20 dB MM, -55 dB SM.
    - c. Temp. Stability: -40°C to 75°C.
  - 2. LC Connector Specifications:
    - a. Typical insertion loss: 0.30 dB MM, 0.5 dB SM.
    - b. Max. Insertion Loss: less than 0.5 dB MM, less than 0.75 dB SM.
    - c. Return Loss: better than -20 dB MM, -55 dB typical SM.
- D. Adapter panels:
  - 1. Provide type as indicated herein in pre-pigtailed configuration, where commercially available.

### **2.4 FIBER PATCH PANEL AND SPLICE CABINETS (RACK/CABINET MOUNTED)**

- A. Provide high density termination and administration point for the fiber cables in the telecommunication rooms with more than 24 fiber terminations meeting the following requirements:
  - 1. Stackable and able to fit within either 19-inch or 23-inch rack frames with twelve adapter panel positions per four-unit (7 inch) frame.
  - 2. Hinged translucent door on the front side of the connector panels
  - 3. Factory installed lock kit for hinged front panel furnished with two keys for each front panel. All enclosures for this project shall be keyed alike.
  - 4. Room and provisions to provide fiber identification.
  - 5. Pre-punched and pre-loaded adapter panels with fiber adaptors of the types specified herein, recessed a minimum of 2.5 inches from the front of the shelf for patch cable

- management. Provide full complement of fiber adapters and adapter panels for each frame. Label unused adapters "SPARE."
6. Fully front and rear accessible. The unit shall slide out to allow top access.
  7. Protection features for the connectorized fiber to prevent mechanical stress, macro-bending losses at the connection point, and tampering with the circuits.
  8. Protection for fiber patching or splicing.
  9. Jumper routing bend limiters.

## 2.5 PATCH CORDS AND JUMPERS

- A. Provide patch cords from same manufacturer as that providing fiber optic cabling. These fibers shall be constructed from glass of the same grade as that used to construct the backbone and horizontal cables.
- B. Multi-mode Patch Cord Specifications: Delete this section if Multi-mode patch cords are not used in the design. Coordinate with Departments requirements.
  1. The fiber patch cord shall consist of buffered, graded index fiber with a 50 micron core and a 125 micron cladding. The fiber coating shall be covered by Aramid yarn and a flame retardant jacket.
  2. Provide two-strand riser rated zipcord style cords for all duplex patch through and equipment connection applications. Provide single strand cords for single equipment connections.
  3. Provide patch cords factory terminated with connectors in the type specified herein in the quantity and length(s) required to make an orderly, manageable connection between all patch panels and equipment being cross-connected.
  4. Mated Connector Loss: 0.3 dB typical, guaranteed maximum 0.5 dB.
  5. Return Loss: better than -20 dB.
  6. Cable Retention: 20 lb. minimum, <0.2 dB change.
- C. Single-mode Patch Cord Specifications: Delete this section if single mode patch cords are not used in the design. Coordinate with Departments requirements.
  1. The fiber patch cord shall consist of buffered, step-index fiber with an 8.3 micron core (typical) and a 125 micron cladding. The fiber coating shall be covered by Aramid yarn and a flame retardant jacket.
  2. Provide two-strand riser rated zipcord style cords for all duplex patch through and equipment connection applications. Provide single strand cords for single equipment connections.
  3. Provide patch cords factory terminated with connectors in the type specified herein in the quantity and length(s) required to make an orderly, manageable connection between all patch panels and equipment being cross-connected.
  4. Mated Connector Loss 0.3 dB typical, guaranteed maximum 0.5 dB.
  5. Return Loss: better than -55 dB.
  6. Cable Retention: 20 lb. minimum, <0.2 dB change.

## 2.6 FIBER OPTIC FLEXIBLE DUCT

- A. Provide conduit innerducts for use with fiber optic cabling in accordance with Section 26 05 34 - Conduit and Fittings.

## 2.7 MULTI-MODE FIBER OPTIC CABLE— 50/125

- A. Multi-mode fiber cable shall be 50  $\mu$ m dual window graded index optical glass with nominal 125  $\mu$ m cladding diameter. The optical fiber shall comply with ANSI/TIA/EIA-492AAAB. Multi-mode fiber for indoor locations shall be of the tight buffered design.
- B. 10 GbE multi-mode fiber shall meet the following specifications:
  1. Maximum Attenuation: 3.5/1.5 dB/km @ 850/1300 nm.
  2. Minimum Overfilled Bandwidth: 1500/500 MHz @ 850/1300 nm.

3. Maximum Distance for Running 1 GbE: 1000/550 m @ 850/1300 nm.
4. Maximum Distance for Running 10 GbE: 300/300 m @ 850/1300 nm.
- C. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have protective coating to ensure color retention, minimize micro-bending losses and improve handling. The coating shall be mechanically strippable.
- D. Indoor rated cable shall meet the flame retardant characteristics required for Plenum rated cable while maintaining mechanical and environmental performance required for outside plant applications. The cable shall consist of a dry block core design meeting all ANSI/ICEA S-104-696 water penetration requirements. The cable shall have an UV protected jacket.

## 2.8 SINGLE-MODE FIBER OPTIC CABLE

- A. Single-mode (SM) fiber cable shall be 8.3  $\mu\text{m}$  (typical) step-index optical glass with nominal 125  $\mu\text{m}$  core/cladding diameter. The optical fiber shall comply with ANSI/TIA/EIA-492CAA. Single-mode fiber for indoor locations shall be of the tight buffered design.
- B. 10 GbE single-mode fiber shall meet the following specifications:
  1. Maximum Attenuation: 0.5/0.4 dB/km 1310 @ nm.
  2. Maximum Distance for Running 10 GbE:  $\geq 10,000$  m @ 1310 nm.
- C. All fibers shall be color coded to facilitate individual fiber identification. Fibers shall have protective coating to ensure color retention, minimize micro-bending losses and improve handling. The coating shall be mechanically strippable.
- D. Indoor rated cable shall meet the flame retardant characteristics required for plenum rated cable while maintaining mechanical and environmental performance required for outside plant applications. The cable shall consist of a dry block core design meeting all ANSI/ICEA S-104-696 water penetration requirements. The cable shall have an UV protected jacket.

## 2.9 FIBER SPLICES

- A. Fiber optic splices are not allowed except where specifically noted on the Drawings or where pre-terminated pigtails are used for fiber terminations. If field conditions are discovered that require additional splices, submit a request in writing to the Department and obtain approval prior to performing splice.
- B. The fiber splice module shall meet the following specifications:
  1. All splices shall be mounted in trays contained in splice closures.
  2. Fusion Splices: Fiber optic splices shall be fusion splices performed in the field by a qualified splicer (Refer to Qualifications paragraph in Part 1 of this specification). Mechanical splices are not allowed. It is possible that a project will have BOTH types of splices, so this sentence needs to be tailored to the situation and not just kept or dropped.
    - a. Fusion splice specifications (at 1300 nm or 1550 nm,  $\pm 5$ nm):
    - b. Typical Splice loss: less than 0.02 dB MM OR less than 0.05 dB SM.
    - c. Integral heat shrink splice protection feature.
    - d. Equipment: Corning M90, or as approved.

## 2.10 LABELING

- A. Provide machine printed labels for all patch panels, cables, etc., in accordance with ANSI/TIA/EIA-606-A. Provide labeling nomenclature in accordance with information on the Drawings or DEPARTMENT's labeling conventions. Submit labeling samples for all required applications.
- B. Machine Printed Label Requirements:
  1. PC Compatible.
  2. Can save and modify files.
  3. Fully integrated with AutoCAD.

4. Editable Fonts and Sizes
  5. Rotate Text and Objects.
  6. Vary Line Spacing.
  7. Ability to import graphical images.
  8. Capable for customization of layout.
  9. Re-positional labels.
- C. Basis of Design:
1. Brady Electrical/Datacomm Worldwide (latest version of LabelMark).
  2. Cable Management Software International (latest version of docIT).
  3. Approved alternate.
- D. Labeling and color coding identification for this project shall conform to TIA/EIA-606-A for a Class 4 Administrative System.

### **2.11 UNSPECIFIED EQUIPMENT AND MATERIAL**

- A. Any item of equipment or material not specifically addressed on the Drawings or in this document and required to provide a complete and functional FODS installation shall be provided in a level of quality consistent with other specified items.

## **PART 3 - EXECUTION**

### **3.1 FACTORY TESTING PROGRAM**

- A. Terminate and test all fiber optic cables on the spools at the factory prior to shipping. Submit factory test reports in accordance with submittal requirements.
- B. Ship fiber spools with factory test terminations in place for re-testing by the Contractor upon receipt.
- C. Receipt Testing:
1. Verify in factory test reports that all fiber cables met all specified testing parameters prior to shipping. Perform receipt testing of fiber on the site or at the Contractor's storage facility. Fibers which do not pass receipt testing may be field terminated and re-tested by the Contractor. All fibers shall pass receipt testing or shall be replaced at no cost to the Department.
  2. Proceeding with fiber installation will be construed as the Contractor's acceptance of materials.

### **3.2 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.3 CABLE INSTALLATION FOR ALL CABLES**

- A. Contractor shall OTDR test each fiber on each reel of received fiber optic cable and report results to Departments Representative prior to installation.
- B. Follow cable manufacturer's specifications regarding handling methods, bend radius and maximum pulling tension limitations.
- C. Install copper cable(s) in the same pathway as optical fiber cable(s) only when the copper cable(s) and the fiber optic cable(s) are installed in separate innerducts. Maintain separation of cable types as much as practicable.

### **3.4 UNDERGROUND CABLE INSTALLATION**

- A. All underground optical fiber cable shall be run in inner ducts. Four 1 inch inner ducts are to be installed in each 4 inch conduit unless otherwise noted on the Drawings. Refer to specification section 26 05 34 - Conduit and Fittings for additional information on inner ducts.

- B. Inner duct shall enclose all optical fiber cable in conduit and ladder rack. Inner duct shall be securely fastened to ladder rack and shall end directly above the rack in which the fiber is terminated.
- C. Inner duct assignment of individual cables shall be as indicated. Cables shall not be placed in ducts other than those specified.
- D. Fiber optic cables transitioning through handholes and manholes shall be enclosed in inner duct and positioned to avoid damage by personnel or equipment.

### **3.5 FIBER SPLICES**

- A. All fiber colors shall be continuous from end to end. No switching or staggering of color scheme within the cable at splice points shall be allowed. Fibers shall be spliced in order.
- B. Cables shall be brought out of the manhole and/or splice enclosure in a controlled environment to perform the fiber fusion splice operation. Splice shall be completed by returning the cable to the manhole and/or splice enclosure such that the excess cable does not impede future entrance and utilization. Cable shall be secured at regular intervals.

### **3.6 BENDING**

- A. Caution shall be used when bending cable to avoid kinks or other damage to the sheath. Bend radius shall be as large as possible with a minimum of 20 times cable diameter. Minimum radius shall be increased when necessary to meet cable manufacturer's recommendation. Cables shall not rest against any sharp edges.

### **3.7 CABLE PULLING LUBRICANT**

- A. Pulling lubricant, shall be used to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Lubricant shall be applied to the cable sheath with a lubricator. When pulling has been completed, the exposed cable ends shall be wiped clean of lubricant.
- B. Lubricants shall be compatible with and intended for use with plastic-sheathed cables. Soap and grease type lubricants are not allowed.

### **3.8 CABLE PULLING**

- A. Pulling lines shall be attached to both cable ends when cable is destined for bi-directional pull, and fitted with factory-installed pulling eyes where possible. Cables not equipped with a pulling eye shall have the pulling line attached to the cable end by means of a cable grip. Core hitches shall not be used.
- B. Cable reels shall be located and aligned so that the cable is payed out from the top of the reel by rotating the reel in the feed direction at the rate of pull into the duct or conduit in a long, smooth bend without twisting. Cable shall not be payed out from the bottom of the reel or by pulling. A cable feeder guide of proper dimensions shall be used at the mouth to guide the cable into the duct or conduit.
- C. Rigging shall be set up at the pulling end so that the pulling line and cable exit on a line parallel with the duct or conduit to prevent either from rubbing against the edge or mouth. Cable ends shall not be pulled around sheave wheels. When the sheave or pulley cannot be positioned to obtain sufficient cable end slack for proper racking and splicing with the pulling line attached to the end of the cable, a split cable grip may be used to obtain the necessary slack.
- D. All equipment and the pulling set shall be checked to minimize interruptions once pulling begins. Cable shall be paid out without stopping until the required amount of the cable has been placed. If the pulling operation is halted before the pull is completed, the tension of the pulling line shall not be released. When pulling is resumed, the inertia of the cable shall be

overcome by increasing the tension in small steps a few seconds apart until the cable is in motion.

- E. Pulling tension shall not exceed 500 lbs or cable manufacturer's recommendation, whichever is less.

### **3.9 DAMAGE AND DEFECTS**

- A. CONTRACTOR shall use a tension monitoring device to ensure that the maximum pulling tension that may be applied to the cable to be pulled into a conduit section is not exceeded. CONTRACTOR shall replace cable if cable manufacturer's maximum pulling tension is exceeded at any time during a pull.
- B. Cable shall be carefully inspected for sheath defects or other irregularities as it is payed out from the reel. When defects are detected, pulling shall stop immediately and the cable section shall be repaired or replaced at the discretion of the Department. A system of communications shall be maintained between pulling and feed locations so that pulling can be stopped instantly, when required.
- C. Cable shall be hand guided through intermediate pull points and into the next duct section when making pull-throughs. Proper rigging shall be used in the intermediate pull points to keep the pulling line and cable aligned with the exit duct to prevent the line or cable from rubbing against the edge of the duct. Cables in intermediate pull points shall be set up and/or racked before the cable ends in adjacent manholes are set up and/or racked.
- D. Cable ends pulled into manholes, vaults, pull boxes, or terminal locations that are not to be racked or otherwise permanently positioned immediately shall be tied in fixed positions to prevent damage to the cables and provide adequate working space.
- E. Adequate care shall be exercised when handling and storing reels of cable to prevent damage to the cable. Cable with dents, flat spots, or other sheath distortions shall not be installed.

### **3.10 SECURING CABLE**

- A. Immediately after cable placement, a permanent identification tag as indicated shall be attached to visible cable sections. Cables shall be checked to ensure that the markings are intact.
- B. Cables and equipment shall be supported and secured as indicated. Where the specific method of support is not shown, supports and fasteners shall be used to secure cables and equipment in position. All cables shall be routed along the interior sides of manholes. Maintain manufacturer's specified minimum bend radius. Cables shall not be kinked during installation.

### **3.11 SEAL**

- A. Ducts or inner ducts located in damp, wet, or exterior locations shall be sealed with urethane foam duct seal. This material shall be inserted between the cable and the duct or inner ducts of which it is in, between the inner ducts and the duct, and in all unused inner ducts, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the manhole or vault.

### **3.12 OPTICAL FIBER DISTRIBUTION UNITS**

- A. All cable terminations shall be made in optical fiber distribution units or rack mounted optical fiber patch panels. All installed fibers shall be terminated.
- B. Optical fiber cables are to be enclosed in flexible duct over their entire length into the fiber distribution unit chassis (FOT Cabinet) or equipment rack.

### 3.13 TESTING

- A. Perform in-place testing of all installed, terminated fibers in accordance with TIA/EIA OFSTP-7 and OFSTP-14 methods. Document and submit all test results in accordance with the Specifications.
- B. Multi-mode Testing:
  1. Perform optical power loss measurements in accordance with TIA/EIA Standard OFSTP-14 using method C. In addition, perform OTDR testing on multi-mode fiber in accordance with tester manufacturers procedures and examine traces for events indicating faults or flaws which may affect network performance.
    - a. Method C: Using an Optical Loss Test Set (OLTS) with hard-copy and disk/CD output capability to test each installed multi-mode permanent link fiber from both directions at 850 and 1300 nm.
    - b. Using an Optical Time Division Reflectometer (OTDR) test each installed fiber from both directions at 850 and 1300 nm for multi-mode fiber permanent link, minus patch cords.
    - c. Calculate and document test results in accordance with TIA/EIA Standard OFSTP-14.
- C. Single-mode Testing:
  1. Perform optical power loss measurements in accordance with TIA/EIA Standard OFSTP-7 using both methods A.3 and B.
    - a. Method A.3: Using an Optical Loss Test Set (OLTS) with hard-copy and disk/CD output capability to test each installed single-mode permanent link fiber from both directions at 1310 and 1550 nm.
    - b. Method B: Using an Optical Time Division Reflectometer (OTDR) test each installed fiber single-mode permanent link fiber from both directions at 1310 and 1550 nm.
- D. Output a graph which indicates the attenuation and distance of each optical fiber for each test performed. The OTDR and associated software shall be Tektronics NetTek OTDR complemented with Target1 Analysis PC Software or approved equal. Note on each page of test output:
  1. Date and Time.
  2. Test Location.
  3. Test Technician's Name.
  4. Test Equipment Used.
  5. Cable number.
  6. Strand number.
  7. Strand Color.
  8. Direction of Test.
  9. Wavelength.
  10. Attenuation.
  11. Length.
- E. Test jumpers shall be of the same fiber core size and connector type as the cable system.
- F. The power meter and the light source shall be set to the same wavelength.
- G. The light sources, OTDR or OLTS shall operate within the ranges of operation specified for 850 nm, 1300 nm, 1310 nm and 1550 nm in accordance with TIA/EIA-526-14 and TIA/EIA-526-7, or the manufacturer's recommendation whichever is the more stringent. Power meters shall be calibrated and traceable to the National Bureau of Standards.
- H. All system connectors, sleeves and jumpers shall be properly cleaned before measurements are taken.
- I. All testing shall be certified as passing testing standards established by TIA/EIA specification for fiber optic cable.
- J. Test Reports:

1. Contractor shall submit optical fiber test results for each fiber installed. Optical Time Domain Reflectometer (OTDR) Optical Loss Test Set (OLTS) output test result graphs shall be provided for each fiber installed on 8.5 inches by 11 inches pages. Also provide output data on MSDOS format 3-1/2 inch floppy diskettes or CD. The OTDR files shall be for use with the OTDR analysis package software. A copy of the OTDR analysis package software, licensed to the Department, shall be delivered to the Department upon completion of the project.

**END OF SECTION 27 20 20**

**SECTION 27 30 10**  
**HEARING IMPAIRED AUDIO SYSTEM (RF)**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Provide as shown on the Drawings and as specified herein a complete Hearing Impaired Audio system to integrate with the sound system(s) noted for Lecture Hall 154.

**1.2 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Provisions, and Division 1.
- B. Submit complete manufacturer's descriptive literature.
- C. Submit complete manufacturer's installation and operation instructions.
- D. Where the manufacturer's instructions/checklists cover multiple pieces of equipment, options and/or installation configurations, neatly annotate the instructions/checklists to indicate only the information applicable to the installation(s) being used for the project.

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. The intent of this Specification is to provide a complete and satisfactory operating system for the pickup, amplification, and reception of voice and/or other audio program material by people with impaired hearing. The system shall be an RF system that translates the line level or microphone electronic signal into a RF signal that shall be transmitted throughout the space by a RF transmitter. The signal shall be received by portable receivers provided for each listener. Portable receivers shall be stored at the location directed by the Department.

**2.2 ACCEPTABLE MANUFACTURERS**

- A. Equipment shall be as manufactured by the Williams Sound Corporation and shall be a Williams Sound Personal PA FM Listening System, Model PPA 377-00.
- B. Substitutions: Items of the same function, performance, appearance and quality will be considered providing that sufficient documentation is provided to satisfy the Department that the equipment meets the requirements of the specification. Submit a line-by-line feature comparison for approval.

**2.3 COMPONENTS**

- A. Transmitter: The transmitter shall be a Williams Sound PPA T35 with the following features.
  - 1. Mounting: One EIA rack space high; ½ wide space.
  - 2. Power Input: 120 VAC, 60 Hz; 17 watts.
  - 3. Power Output: 24 VAC, 500 mA.
  - 4. Operating Frequencies:
    - a. 72.1 - 75.9 MHz, 10 wide band channels (selectable) 7 non-standard wideband channels (selectable).
    - b. 72.025-75.975 MHz, 77 narrowband channels (selectable)
  - 5. Frequency Accuracy: +/- .005% stability, 0-50 degrees C.
  - 6. Deviation:
    - a. Wideband: +/- 75 kHz maximum.
    - b. Narrowband: +/- 5 kHz maximum.
  - 7. RF Field Strength: Not exceeding 8 mV/m at 3 m.
  - 8. Nominal Range: 1000 feet (using ANT 005 coaxial antenna).

9. Frequency Response: 22 - Divisions 26, 27, and 28 Hz, +1, -3 dB (adjustable)
  10. Signal To Noise Ratio: 74 dB transmitted.
  11. Audio Level Control: Push button audio level controls, adjustable from 0 to -50 dB.
  12. Audio Level Indicators: 10 LED array that reads +9 to -18 at 3 dB intervals.
  13. Phones Output: Mono signal, ¼ inch TRS stereo jack, 67 mW.
  14. Audio Input: Combination 3 pin XLR, ¼ inch TRS jack.
  15. Line Output: RCA jack, -10 dB V (.32 VRMS) output.
  16. LCD Menu Controls: Applications Preset (Music, Voice, Hearing Assistance), Bandwidth, Frequency, Audio Input Source (Microphone, Line, Simplex), High Pass Filter, Compressor Slope, Compressor Gain, RF Output Power.
  17. Provide (1) transmitter for each individual area sound system.
- B. Receiver: The receiver shall be a Williams Sound PPA R37 with the following features.
1. Case: Gray polycarbonate impact resistant plastic.
  2. Battery Type: Two (2) AA alkaline non-rechargeable or NiMH rechargeable.
  3. Operating Frequency: Pre-tuned, adjustable 72 Mhz - 76 MHz.
  4. Receiver Antenna: Integral with earphone/headphone cord.
  5. Input Connector: 3.5 mm mono phone jack.
  6. Earphone (standard): Earbud type with foam cushion.
  7. Battery Life: 100 hours (non-rechargeable)
  8. Frequency Response: 100 - 15 kHz, +/-3 dB.
  9. Output: 35 mW, max at 15 ohms.
  10. Provide (4) receivers for each individual area sound system.
- C. Accessories
1. Single mini earbud earphone: EAR 013. Provide (1) for each receiver unit.
  2. Single rack-mount kit for half rack space products: Model RPK 005. Provide (1) for each transmitter unit.
  3. Remote coaxial antenna for 72-76 Mhz PPA Transmitters: Model ANT005. Provide if required to ensure proper coverage. Field coordinate mounting location with the Department.

### **PART 3 - EXECUTION**

#### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

#### **3.2 COMPLETE SYSTEM**

- A. The CONTRACTOR shall provide all equipment, material, cable, conduit, supplies, power connections and labor to provide an effective, complete and workable system.
- B. Provide all connections to properly interface the Hearing Impaired Audio System with the Sound System as recommended by the sound system manufacturer.

#### **3.3 MOUNTING**

- A. Mount equipment in locations and arranged as indicated on the Drawings, as specified herein, in accordance with the requirements of all Sections of this Division and in compliance with the manufacturer's directions and instructions.

#### **3.4 INSTALLATION**

- A. Install equipment to comply with manufacturer's recommendations.
- B. All wiring shall be in conduit.
- C. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

**3.5 TESTING**

- A. Test hearing impaired system to ensure complete coverage in the area where the equipment will be used.
- B. Test all receivers for proper operation.

**END OF SECTION 27 30 10**

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**SECTION 27 41 16**  
**AUDIO VIDEO SYSTEMS AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Specification Section 27 41 16 - Audio Video Systems and Equipment to be completed by Addendum.
- B. Section includes:
  - 1. Multi-sync liquid crystal displays with mounts
  - 2. Video projection system with mount
  - 3. RGB matrix switcher
  - 4. Touch screen control system
  - 5. Ethernet control system
  - 6. Universal computer interfaces
  - 7. Cabling
  - 8. Audio amplified speakers
  - 9. Video/Audio Conferencing System
  - 10. Video projector and screen
  - 11. Miscellaneous equipment
  - 12. The work described in this specification includes all labor, materials, equipment, appurtenances, and services necessary to install and test the products required for a physically complete and fully functional Audio/Video (A/V) systems. Materials not specifically mentioned in this specification, or not shown on the Contract Drawings, but required for proper performance and operation of the systems, shall be provided by the Contractor.
  - 13. Perform all work, provide products, systems integration, programming, engineering, design work, and testing required for the project in order to ensure fully functional systems and proper installation of equipment.
- C. Related Documents: The provisions and intent of the Contract, including the General Conditions, Supplementary Conditions and General Requirements, apply to the work.
- D. Related Sections:
  - 1. Section 27 20 10 - Telecommunications Distribution System
  - 2. Section 28 13 33 - Security Management System
  - 3. Section 27 20 10 – Telecommunications Distribution System
  - 4. Electrical Divisions - Electrical: All sections of Electrical Divisions shall apply.

**1.2 REFERENCES**

- A. Specific reference in the specifications to codes, rules, regulations, standards, manufacturer's instructions or requirements of regulatory agencies shall mean the latest printed edition of each in effect at date of contract unless the document is shown dated.
- B. References:
  - 1. American National Standards Institute (ANSI)
    - a. ANSI C2 (Latest Revision): National Electrical Safety Code
  - 2. National Fire Protection Association (NFPA)
    - a. NFPA 70 (Latest Version): National Electrical Code
  - 3. Underwriters Laboratories (UL)
    - a. UL 6: UL Standard for Safety Rigid Metal Conduit
    - b. UL 797: UL Standard for Safety Electrical Metallic Tubing
    - c. UL 1242: UL Standard for Safety Intermediate Metallic Conduit

### 1.3 SUBMITTALS

- A. Provide Submittals for all products in this section in accordance with the requirements of Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Prepare coordination drawings detailing major elements, components, and integration into millwork, conference room tables, operator position furniture, floor boxes and wall plates.
- C. Unless specified otherwise in specific sections the submittal requirements shall be applicable to all equipment contained in this section. Gather Section 27 41 16 Audio Video Equipment data together and organize and present as one unified submittal.
- D. Submit manufacturer's information on all hardware and software.
- E. Product Data Submittals:
  - 1. Submit catalog cut sheets, technical data sheets, manufacturer specifications and/or diagrams necessary to illustrate a product, material or system for some portion of the work. Product data literature is required on all items of material and equipment and should be clearly marked; identifying specific items proposed with a reference to the specification requirement the item is being submitted for.
  - 2. Product data shall include adequate descriptive literature and catalog cut sheets required for the Department to ascertain that the proposed equipment and materials comply with specification requirements.
- F. Drawings:
  - 1. Signal flow block diagrams from the digital signal processor software.
  - 2. Detail drawings of device mounting.
  - 3. Detail elevation drawing of Large LCD pole mount system with ergonomic furniture.
  - 4. Screen shots of control system and menu tree flow diagram of screens for control system.
- G. Record Shop Drawings: Provide a copy of corrected, approved shop drawings for the project, updated to show as-built condition. Include the manufacturers' brochures in the "as-built" documentation. Plans shall indicate exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag. Prepare "as-builts" using the latest release of AutoCAD and deliver files to the Department.
- H. Warranty information: All materials relating to warranties.
- I. Manufacturer's training certifications of service personnel.
- J. Manuals:
  - 1. Provide complete sets of manuals and other information necessary for the operation and maintenance of the system in accordance with Division 1 requirements.
  - 2. Manuals: Manuals shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system.
    - a. The manuals shall have a table of contents and tab sheets.
      - 1). Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix.
      - 2). The final copies delivered after completion testing shall include all modifications made during installation, checkout, and testing.
  - 3. Design Manual: Design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.
  - 4. Operator's Manual: The operator's manual shall describe operation of all modified software and hardware provided.
  - 5. Maintenance and Service: The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components. Manufacturer's repair manuals shall include the equipment physical layout and schematics to the device level.

6. Operation and Maintenance manuals shall be fully corrected to include review comments prior to final submission to the Department.

#### **1.4 TRAINING**

- A. System Overview: Conduct an on-site system overview for the Facility (separate from the systems testing) to instruct the users on the scope and operations of the system.
- B. Provide on-site training by a qualified, factory-trained instructor for designated maintenance technicians and operations personnel on the operation and maintenance of the system(s). If trained personnel from the factory are required for training, they shall be provided on-site by the Contractor at no additional cost to the Department.
- C. Provide the following training upon completion of final testing and acceptance of the systems:
  1. Demonstrate operation of system during System Overview tour. Demonstrate the system in all modes of operation.
  2. Maintenance training shall cover all technical training required for maintenance, preventative maintenance and system adds, moves and changes including detailed instructions on system software modifications.
  3. Provide course syllabus for all training courses in advance of each course, with outline of topics, time allotted for each topic, targeted audience and training objectives. Submit training manuals to Department for review and approval a minimum of ten (10) working days in advance of scheduled training. Training shall not commence until training syllabus has been approved.

#### **1.5 QUALITY ASSURANCE**

- A. The equipment manufacturers shall have been in business manufacturing similar products for at least 5 years.
- B. Bidder qualification: Equipment shall be installed by qualified individuals having at least five (5) years experience installing and maintaining similar equipment. The qualified individuals shall have installed at least two (2) systems of similar type and size within the past five (5) years. Submit evidence of successful installation, Owner training and maintenance for a minimum of the previous five years. Provide listing of projects with verifiable reference names and telephone numbers.
- C. The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to install and maintain/repair the system after system acceptance. The Contractor shall maintain a fully staffed office within two (2) hours travel time from the job site.
- D. Personnel:
  1. Installing personnel shall be qualified to accomplish all work promptly and satisfactorily.
  2. Personnel shall have attended the manufacturer's training school(s) for equipment being installed. Provide certificates of completion or other documentation showing manufacturer certification.
  3. The Department shall be advised in writing of the name of the designated installation representative(s) and of any change in personnel during installation of the project.

#### **1.6 WARRANTY AND SERVICE**

- A. Warranty shall commence in accordance with the final completion date and shall not be a function of material delivery dates.
- B. Warrant all components, parts and assemblies against defects in materials and workmanship for a period of 12 months from final completion. Warranty service shall be provided by a trained specialist of the equipment manufacturer.

- C. Service/Maintenance:
  - 1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
  - 2. Extended service/maintenance agreements shall be offered by the Contractor for up to four years after the warranty expires. The agreement shall be renewable quarterly, or yearly. Submit 90 days prior to final inspection.
- D. System operation verification: Performance of scheduled adjustments and repair shall include verification of operation of the system as demonstrated by the applicable tests of the field test.
- E. System modifications: Make all recommendations for system modification in writing to the Department.
  - 1. No system modifications, including operating parameters and control settings, shall be made without prior approval of the DEPARTMENT'S designated representative.
  - 2. Modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT**

- A. Product substitutions:
  - 1. Named manufacturers are the Basis of Design for the system.
  - 2. Submit product literature and a complete compliance checklist showing compliance with individual specification paragraph performance requirements in accordance with Division 1.
- B. CONFERENCE ROOM 255 and 245 and CLASSROOM 113
  - 1. Intent
    - a. The intent is to provide a complete and fully functioning combination audio/video and video conferencing system in accordance with the Drawings.
  - 2. System Furniture
    - a. Audio/Video Equipment Rack - Middle Atlantic ASR-30 or approved equal.
      - 1). Audio/Video Equipment Rack - Middle Atlantic CLS-COOL closet cooler system, finish to match casework.
  - 3. Active Equipment
    - a. Shelf mounted computer with HDMI output and Blu-Ray Optical drive - Department Furnished, Contractor Installed.
    - b. Video Conferencing Equipment
      - 1). Polycom HDX 7000 System with CCTV camera, required mount(s), microphones etc. or approved equal. Department Furnished, Contractor Installed.
      - 2). Audio Amplifier - Crown 280A or approved equal.
  - 4. Passive Equipment
  - 5. Cabling and Connectors
  - 6. Device Plates and Connectors
- C. LECTURE HALL 154
  - 1. Intent
  - 2. System Furniture
  - 3. Active Equipment
    - a. RGB Matrix Switcher:
      - 1). stuff here
    - b. Touch Panel: Provide one color touch screen for the A/V control system installed in Lecture Hall 154 moveable podium. Specifications shall include:
      - 1). A touch active color matrix LCD.
      - 2). 7" diagonal screen size.
      - 3). 800 x 480 pixels.

- 4). Design Selection:
  - a) Extron TLP-710CV, or approved equal
- c. Microphone
- d. Video/Audio to UTP Converter
- e. UTP to Video Audio Converter
- f. DVD Player:
  - a) Rack mount.
  - b) Capable of playing DVD-+R, DVD-+RW, CD-R, CD-RW, MP3, and video and super video CD.
  - c) Provide with component video outputs and an RS232 control input.
  - d) Design Selection:
    - i. Denon DN-V310
    - ii. Or approved equal
- g. Video Scaler: The video scaler shall scale analog video feeds to match the signal types for the inputs on the RGBS Matrix Switcher. Scaler shall:
  - 1). Accept S-Video, Composite or component video connections.
  - 2). Provide DVI-I or VGA output.
  - 3). Support output resolutions of 800x600, 1024x768, 1280x1024, line double, line quadruple.
  - 4). Remote RS232 port for control.
  - 5). Lockout front panel controls.
  - 6). Design Selection:
    - a) Extron DVS304, or approved equal
- 4. Passive Equipment
- 5. Cabling and Connectors
- 6. Device Plates and Connectors
- D. Cabling and Accessories:
  - 1. All rack-mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the cabinet. Except where otherwise described or shown, cables shall be as short as practicable for each signal path without causing strain at the connectors.
  - 2. RGBHV Video Cabling: Cabling shall provide the correct level and frequency capabilities for the distances of transmission. Cables shall include:
    - a. Plenum Rating.
    - b. RGBHV coaxial conductors.
    - c. Incorporate audio cabling in cable assembly when applicable.
    - d. Incorporate Control Network or RS-232 Data control in cable assembly when applicable.
    - e. Mini Hi resolution cable acceptable for internal cabinet connections.
    - f. RG59 video cable required as a minimum for display connections to system.
    - g. BNC and RCA connectors shall be solderless and be a manufacturer recommended connector for the cable supplied.
    - h. Design Selection:
      - 1). Extron Cabling – Bulk Cable
      - 2). Liberty Wire and Cable
      - 3). Belden
      - 4). Or approved equal
  - 3. Audio Cable:
    - a. Be plenum except for inner rack or cabinet wiring.
    - b. Provide a shielded twisted pair for each audio channel.
    - c. Have 34pF/ft capacitance or less between conductors.
    - d. Have minimum 22 AWG conductors.
    - e. Design selection:
      - 1). Extron Cable - STP 20 Dual Plenum

- 2). Liberty Wire and Cable - 22-2P-CMP-SIAMEZ
  - 3). Belden Cable
  - 4). Or approved equal
4. Video Cable:
- a. Plenum rated unless it is for inner cabinet wiring.
  - b. RG 59/U coaxial signal cable shall have shielding which provides a minimum of 95 percent coverage, a solid copper center conductor of not less than 22 AWG.
  - c. Design Selection:
    - 1). West Penn cable
    - 2). Belden
    - 3). Or approved equal
5. Control System Cable — Cabling shall provide control signals to components connected to control system main processor. Cabling shall:
- a. Provide all control signaling required for RS-232 Data and Crestnet/AMX communications.
  - b. Plenum rated.
  - c. Design Selection:
    - 1). Liberty Wire and Cable for Control Network.
    - 2). Liberty 24-2P-PLCSH-WHT for additional RS-232 data signals.
    - 3). GEPCO
    - 4). Or approved equal
6. Computer Interface Cable - Computer interface cabling shall include RGS cable with audio and additional conductors (UTP) sized to power computer interface. Cabling shall be plenum rated.
- a. Design Selection:
    - 1). Extron Cable
    - 2). Liberty Wire and Cable
    - 3). Belden
    - 4). Or approved equal
7. Speaker Cable - Provide UTP cabling. Loudspeaker signal lines shall be sized to allow no greater than 5 percent loss from source to first speaker. Lines shall be twisted pair, Plenum jacketed with no shield.
- a. Minimum conductor strand count: Nineteen (19)
  - b. 2 conductors, #12 AWG.
  - c. UM type CMR or CL3R.
  - d. Design Selection:
    - 1). Belden 6000UE Series
    - 2). Or approved equal

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Existing conditions: Prior to starting work, Contractor shall certify existing conditions and requirements to install A/V equipment.
- B. Inspection: Determine that area is available as required for equipment installation.
- C. Variations: Contract Drawings and other Documents indicate basic location, arrangement, and routing of equipment and components.
- D. Improvements and modifications of layout to accommodate Contractor's proposed equipment and detailed designs will be considered by the Department.
- E. Submit proposed design modifications to the Department for approval.
- F. Do not proceed on incorporation of modifications and associated work until receiving written approval from the Department.

### 3.2 GENERAL

- A. System installation and construction methods shall conform to the codes and requirements of the State of Alaska, City of Juneau, and as stated in the Special and General Provisions of the Contract Documents.
- B. Install equipment to meet seismic requirements of the State of Alaska and the UBC.
  - 1. Where undefined by codes and standards, apply a safety factor of at least 2 times the rated load to all fastenings and supports.
- C. Install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, NFPA 70, ANSI-C2, and State and local codes and as shown, and shall provide all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- D. System components and appurtenances shall be installed in accordance with the manufacturer's instructions and as shown.
- E. Conduit and Boxes: All interior wiring, including low voltage wiring outside the control consoles and equipment racks, cabinets, boxes, and similar enclosures that is exposed shall be installed in rigid conduit conforming to UL 6, wiring that is concealed in walls or located above ceilings shall be installed in (EMT) conforming to UL 797.
- F. Supply all other system Conduit and Fittings required for system installation.
- G. Interconnection wiring between components mounted in the same rack or cabinet, or between a series of racks does not need to be installed in conduit.
- H. Flexible cords, cord connections, or flexible conduit shall not be used for system installation, except where specifically shown or approved by the Department.
- I. All other electrical work shall be as specified in Electrical Divisions.
- J. Match existing Finishes with all material as required.

### 3.3 TESTING AND COMMISSIONING

- A. General: Perform site testing and adjustment of the completed A/V systems on a room by room and system by system basis in accordance with Specification 16789 and the following:
  - 1. Document all testing. Signal values shall be provided on as-built drawings. Include signal level of any reference sources used to derive as built signal levels.
  - 2. Testing shall include operation of touch screen/GUI systems for every possible scenario of screen configuration. Document that audio and video selection scenarios have been tested on a matrix spreadsheet in Excel format.
  - 3. Verify video signal level to displays and adjust level and peaking controls on interfaces to insure system matches .707-volt level and matching rise time of sources. Utilize oscilloscope when making these adjustments. Document this testing has been completed.
  - 4. Color-balance all displays to achieve CIE standards for 6500 degree Kelvin standards for XYZ stimulus values. Print before and after test results. Acceptable test equipment
    - a. Sencore CP5000 Color Analysis system with calibrated Test signal Generator
    - b. Or approved equal
  - 5. Test and document that audio levels have been matched to the greatest extent possible in the video matrix and RGB matrix. Provide averaged dBu output levels for each source by output.
  - 6. Perform speaker impedance with speaker impedance bridge and polarity test on ceiling speaker circuits. Also test for ground faults.
  - 7. Perform audio system equalization with Pink noise source. Ensure frequencies are equalized to provide flat signal response across the speakers' effective range of sound.
  - 8. Manufacturer shall field test all equipment to verify operation including control of devices connected to control system.

9. Demonstrate equipment operation for Engineer including control of equipment from the Control System. Provide control system programmer for minor changes after system demonstration.

**END OF SECTION - 27 41 16**

**SECTION 27 51 23  
PUBLIC ADDRESS SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The Contractor shall furnish, install and place in operation an electrically powered system for paging and program signaling, The system shall include, but not be limited to, amplifiers, zone paging controller, telephone interface, power supplies, peripheral instruments, speakers, baffles, wire and accessories required to provide a complete and operational system.

**1.2 CODES AND STANDARDS**

- A. All wiring shall be in accordance with the requirements of Article 725 of the National Electrical Code for Class 2 Signaling Systems, applicable local codes and manufacturer's wiring diagram.

**1.3 TYPE OF SYSTEM**

- A. These specifications are based on a Bogen Zone Paging System to set a standard for design and quality.
- B. Substitutions may be submitted for approval, provided that sufficient documentation is provided to satisfy the Department that the equipment meets the requirements of this specification. Refer to Division 1 for substitution requirements.

**1.4 INTEGRATION WITH TELEPHONE SYSTEM**

- A. Access to the paging system control functions from an outside phone line shall be provided. Off-site paging shall be possible by dialing into a designated (unpublished) telephone number.

**1.5 SUBMITTALS**

- A. Provide Submittals for all products in accordance with Section 26 00 00 – Electrical General Requirements and Division 1.
- B. Submit for approval manufacturer's catalog information with complete description of all panel mounted and remote equipment.
- C. Include complete one-line risers and point-to-point wiring diagrams produced specifically for this installation.
- D. Clearly identify product model numbers and options for equipment used on this project by circling, highlighting, or pointing out information on manufacturer's data sheets.

**1.6 DEPARTMENT'S MANUALS**

- A. Furnish six complete sets of Department's Operation and Maintenance manuals and other information necessary for use and upkeep of the system. Manuals shall be completed and approved prior to Operator's training.

**1.7 DEPARTMENT TRAINING**

- A. Provide four (4) hours on-site operator training to the Department prior to final acceptance. Department's Manuals shall be used during training.
- B. Within thirty (30) days of final acceptance provide four (4) additional hours follow-up on-site operator training. Arrange a time agreeable to the Department.

## 1.8 GUARANTEE AND SERVICE

- A. All components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of 12 months from the date of final acceptance.
  - 1. Warranty service shall be provided by a trained specialist of the equipment manufacturer.
  - 2. The specialist shall be based in a fully-staffed branch office located within a reasonable distance from the job site.
- B. The equipment manufacturer shall have a local branch office staffed with trained, full-time employees who are capable of performing testing, inspection, and repair and maintenance services for the life of the system.
- C. The equipment distributor shall offer the Department an annual service contract at the end of the one year warranty period. Acceptance or rejection of the service contract will be the DEPARTMENT's option.

## PART 2 - PRODUCTS

### 2.1 PAGING SYSTEM

- A. The zone paging system shall be the Bogen PCM2000 Zone Paging System, designed for direct connection to loop start and ground start trunks, to PBX or KEY paging ports which supply DTMF capability and to analog T/R lines. The unit shall allow total system amplifier power of up to 250W. Provide additional amplifiers, zone paging modules, and central processing modules to sufficiently power the quantity and types of speakers as shown on the drawings and as specified herein.
- B. The unit shall include flanges with keyhole slots for rack-mounted installation. Operation shall require a 12V (1.5A) DC power supply. A suitable power supply shall be provided (PCMPS2 power supply).
- C. The system shall consist of the appropriate modules as specified and shall be registered under Part 68 of FCC rules.

### 2.2 MODULES

- A. All modules shall be designed for wall-mounted installation. All modules shall be equipped with a ribbon cable and connector and power cable with connector to permit them to be interconnected to each other. The face plates of each module shall be finished in black, with each control/connector clearly labeled in white. Each face plate shall have knockouts to facilitate cable and wire dressing. All connections shall be made using a small regular screwdriver or common jacks (RJ11 or RCA).
- B. The following modules shall be available:
  - 1. PCMTIM - Telephone Interface Module. One PCMTIM module shall be provided per PCM2000 system. The module shall provide for telephone interface selection via built-in DIP switches. It shall include a volume control for tone and 8GM source, and RJ 11 jacks for night ringer, telephone line, and override. A connector block, using screw terminal connections, shall be provided for BGM source, and two (2) C-form relay contact sets. A power-on LED indicator shall be provided to indicate power-applied status.
  - 2. PCMCPU - Central Processing Module. One PCMCPU module shall be provided for the first nine (9) zones in the system. One PCMCPU module shall be needed for each satellite system. The module shall provide for satellite system identification via built-in DIP switches. It shall include a locking program/run selector switch (with program LED), satellite data link RCA jack, and 1 2V DC power source jack. A connector block, using screw terminal connections, shall be provided for paging amplification connection, low-power and high-power BGM connections, emergency/shift change signal activation, AUX contact closure, and 1 2V DC power source connection. A power-on LED indicator shall be provided to indicate power-applied status.

3. PCMZPM - Zone Paging Module. One PCMZPM module shall be provided for each three (3) paging zones in the system. Up to three (3) PCMZPM modules may be connected to the master system, for a total zone capacity of 9 zones. Up to three (3) additional PCMZPM modules may be connected with a PCMCPU module to form a satellite system to further increase zone capacity. The PCMZPM module shall provide built-in DIP switches to set talkback on/off for each zone. It shall include a power-on LED, low-power background music volume control, background music out/in jumper field, local BGM selection jumpers, and high-power/low-power operation selector switch. A connector block, using screw terminal connections, shall be included to connect local background music, zone wiring, and relay driver outputs.
- C. The PCM Zone Paging System shall supply the following features and functions:
1. Simultaneous high-power and low-power paging. Total system high-power audio capacity of 250W.
  2. A minimum of three paging zones and maximum zone capacity of ninety-nine (99) paging zones. The system shall be expandable in groups of three zones.
  3. Up to 32 field-programmable paging zone groups, each consisting of 1 to 99 zones.
  4. Field programmable Night Ringer Zone Group, consisting of from 1 to 99 zones. This feature shall be activated by high-voltage ring signal or contact closure.
  5. Field programmable Emergency/Shift change Zone Group, consisting of from 1 to 99 zones. This feature shall require activation by a customer-supplied contact closure, and sound a user-selected tone. The user shall have the choice of no tone (allowing use of outside tone source), tone burst (1-7 sec. duration, user-selected), single chime, or quad beep.
  6. Emergency All-Facility Page Override. This feature shall be activated through a loop start trunk or through contact closure and dry audio input. It shall override the normal paging features of the system, sound a user-defeat able alert tone in all zones, and open an audio channel for a voice page.
  7. Built-in, talkback amplification of central-amplified zones. This feature shall require the addition of the PCMTBM module.
  8. Background music assigned per zone and local background music sourcing capability.
  9. Field programmable Code Call Zone Group, consisting of from 1 to 99 zones. The user shall have the choice of pattern or echo code calls, and repeat functions.
  10. Eight daily time-triggered signaling events. This feature requires the use of the PCMTBM module.
  11. Two (2) C-form relay contact sets for activating external equipment. The contacts shall change state when the unit is activated.
  12. Capability of providing uninterrupted background music to all zones not being paged.
  13. Non-volatile RAM shall be included to allow for retention of programming information during power interruptions
  14. Screwdriver-adjustable volume control of confirmation, pre-announces, error, and shift change/emergency-call tones.
- D. The equipment, except for program sources and monitor panel, shall be contained in a full height NEMA standard open floor-mounted rack frame as specified in Section 27 20 10 – Telecommunications Distribution System. The rack shall be located as noted on the Drawings in the Main Telecommunication Room (MTR).

### 2.3 PERIPHERAL SYSTEM COMPONENTS

- A. Conventional Speakers:
1. The speaker/transformer Assembly shall be a TOA F-2852C or as approved, furnished and installed as indicated on the plans and as recommended by the manufacturer.
  2. The speaker shall be an 6-1/2 inches bass reflex type. It shall have a frequency range of at least 60 Hz to 20,000 Hz and a 60-watt rated input (High Impedance).

3. The speaker assembly shall be equipped with dual-winding (25V/70V) line matching transformer. It shall provide power taps nominally rated at 1.5W, 7.5W, 15W, 30W, and 60W at 70V operation. It shall have corresponding taps at 25V.
- B. Solid Drive Speakers: Where called for on the Drawings, provide Sound Tube SD1 Solid Drive audio drivers mounted on the appropriate surface in accordance with the manufacturer's instructions. Connect to P/A system head end.
- C. Baffle and Enclosure:
  1. Provide speaker baffles and enclosures as recommended by the manufacturer.
- D. Wire Types: Paging Amplifier to speakers shall be two conductor, 20 gauge jacketed, plenum rated; West Penn Wire 25222B as approved.

#### **2.4 PAGING SYSTEM AMPLIFIER(S)**

- A. Provide Bogen TPU250, 250W paging system amplifier (quantity as required) or as approved.

#### **2.5 COMPLETE SYSTEM**

- A. Any item of equipment or material not specifically addressed on the Drawings or in this document and required to provide a complete and functional P/A System shall be provided in a level of quality consistent with other specified items.
- B. All fittings, terminations, amplifiers, relays, switches, wiring, conduit, functional modules, custom programming and fabrication, testing and balancing, etc., needed to provide the best performance possible at the present state of the art shall be supplied at no additional cost.

#### **2.6 OVERVOLTAGE PROTECTION**

- A. Head-end equipment shall incorporate a UL1449 listed device to protect all solid state equipment against power line surges and power line over-voltages.

### **PART 3 - EXECUTION**

#### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

#### **3.2 INSTALLATION**

- A. Mount the head end equipment in the MTR as designated on the plans.
- B. Install conductors in accordance with Section 26 05 10 - Wire and Cable. Field devices shall be installed in accordance with Section 26 05 00 - Basic Materials and Methods.
- C. Refer to Architectural elevations and reflected ceiling plans and electrical drawings for locations and mounting heights of devices and equipment. Coordinate special framing or mounting requirements with other trades for proper installation.

#### **3.3 TELEPHONE SYSTEM COORDINATION**

- A. Coordinate all aspects of the Paging-Telephone system interface with the Telephone system to ensure the implementation of all system features and functionality.

#### **3.4 WIRING REQUIREMENTS**

- A. All wiring shall be in conduit.
- B. All wiring shall be sized per the manufacturer's recommendations. Each type shall be approved for the specific application.

- C. All wiring connections to the Paging system shall be via terminal blocks mounted in the open frame rack.
- D. All wiring shall homerun to rack mounted terminal blocks in the Main Telecommunication Room (MTR).

### **3.5 PAGING ZONES**

- A. Provide individual speaker paging zones as follows:
  - 1. Lobby
    - a. Lobby Atrium (1<sup>st</sup> Floor)
    - b. Lobby Atrium (Gallery Level)
    - c. Lobby Atrium (2<sup>nd</sup> Floor)
  - 2. Lecture Hall 154
  - 3. Classroom
  - 4. Exhibit Spaces (Future zone under a separate Tenant Improvement)

### **3.6 SYSTEM TESTING AND BALANCING**

- A. The system shall be fully tested and balanced by a qualified technician prior to final acceptance. Make final adjustments to the system to the satisfaction of the Department.

**END OF SECTION 27 51 23**

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## SECTION 28 13 33

### SECURITY MANAGEMENT SYSTEM

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. The intent of this Specification is to place in working order a complete, fully tested and documented integrated Security Management System (SMS) complying with the Codes and Standards referenced herein.
- B. The Security Management System outlined in this section and detailed in Part 2 of this document is the key central component for managing physical security and the bridge between physical and logical security for this project. The system shall provide a variety of integral functions including the ability to regulate access and egress; provide identification credentials; monitor, track and interface alarms.

##### 1.2 CODES AND STANDARDS

- A. The Codes and Regulations listed below form a part of this specification to the extent referenced. Work shall be performed in accordance with the applicable international, federal, state, and local codes or standards current at the commencement of installation. The following list summarizes applicable standards:
  - 1. UL 294, "Access Control System Units"
  - 2. UL 1076, "Proprietary Burglar Alarm Units and Systems"
  - 3. FCC – Part 15 "Radio Frequency Devices"
  - 4. FCC – Part 68 "Connection of Terminal Equipment to the Telephone Network"
  - 5. NFPA 70, NEC
- B. Where more than one code or regulation is applicable, the more stringent shall apply.

##### 1.3 SUBMITTALS

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1. Submittals shall include the following:
  - 1. Product Data: Provide complete product data that includes the following:
    - a. Manufacturer's technical data for all material and equipment at the system and sub system level to be provided as part of the SMS.
    - b. A system description including analysis and calculations used in sizing equipment required by the SMS. The description shall show how the equipment will operate as a system to meet the performance requirements of the SMS. The following information shall be supplied as a minimum:
      - 1). Server(s) processor(s), disk space and memory size
      - 2). Description of site equipment and its configuration
      - 3). Network bandwidth, latency and reliability requirements
      - 4). Backup/archive system size and configuration
      - 5). Start up operations
      - 6). System expansion capability and method of implementation
      - 7). System power requirements and UPS sizing
      - 8). Device / component environmental requirements (cooling and or heating parameters)
      - 9). A description of the operating system and application software.
  - 2. Shop Drawings
  - 3. O&M Manuals: The manuals shall consist of the following:
    - a. Hardware Manual
    - b. Software Manual

- c. Operators Manual
- d. Maintenance Manual
- 4. As-Built Drawings

#### 1.4 QUALITY CONTROL

- A. Manufacturer Qualifications
  - 1. The manufacturer of the SMS shall be an established organization with referenced and documented experience delivering and maintaining Security Management Systems of equal or higher sophistication and complexity as compared to the system detailed in this specification.
  - 2. SMS Manufacturer shall employ at a minimum the following methods for QA of component and assembly devices.
    - a. Visual inspection of devices shall be performed to verify assembly according to defined procedures.
    - b. End of line operational tests shall be performed to ensure product functionality has been correctly configured.
    - c. A system burn-in period shall be utilized to screen for early life failures of electronic components.
  - 3. Individual functionality and system level regression testing shall be performed to ensure compliance with product specifications. Single and multiple unit system tests shall be performed to mimic end-user installation configurations. Automated hardware and software testing shall be utilized to evaluate system performance under published operational loads and shall be compared to published system capabilities.
- B. Bidder Qualifications
  - 1. At the time of the bid, the bidder shall have satisfactorily completed projects similar in size, scope and complexity as the system detailed in this specification and on the drawings. The bidder shall furnish written proof of experience from three (3) references and proof of current accreditation/certification by the manufacturer for required training for sales/installation/service of the SMS and associated devices.
  - 2. The bidder shall also be a factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for the SMS and related systems under this contract.

#### 1.5 WARRANTY

- A. SMS Software and Field Hardware Warranty
  - 1. SMS Software and Hardware shall be warranted for a period of one (1) year from the date of Substantial Completion, be free of defects, and will function in accordance to this Specification. This one (1) year warranty shall include any third party devices and device warranties necessary or required to make a fully functional system as specified herein and as shown on the drawings. Third party devices include (but are not necessarily limited to) devices that are directly interconnected to the SMS field hardware or computers and are purchased directly from the SMS manufacturer. Examples may include; Credential Printers, Reader Heads, Biometric Devices, Computers, etc.
- B. Installation Warranty
  - 1. CONTRACTOR shall warrant all SMS equipment and labor for a period of one (1) year from date of Final Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. SMS Software
  - 1. The Security Management System software shall be manufactured by Lenel Systems International

- B. SMS Field Hardware
  - 1. Lenel Intelligent System Controllers (ISC)
  - 2. Lenel Intelligent Single Door Controller (ISDC)
  - 3. Lenel Intelligent Dual Reader Controller (IDRC)
  - 4. Lenel Single Reader Interface Module (SRI)
  - 5. Lenel Dual Reader Interface Module (DRI)
  - 6. Lenel Input Control Modules (ICM)
  - 7. Lenel Output Control Modules (OCM)
  - 8. Lenel ancillary devices as required
- C. SMS Authentication Hardware
  - 1. HID iClass, 13.56 MHz contactless Smart Card – Model R40
  - 2. HID iClass, 13.56 MHz contactless Smart Card with Integral Keypad where called for on the Drawings – Model RK40
  - 3. HID iClass, 13.56 MHz contactless Smart Card where space prohibits use of HID R40 or as directed by the Department on a specific case by case basis - Model R15 or R10.
    - a. These are some other compatible authentication hardware options, use HID iClass as default unless something else is requested.
- D. SMS Credential Printers
  - 1. The SMS credential management module shall be compatible with printers and printer/encoders from Zebra, Magicard and Nisca
- E. SMS Third Party Integrated Devices
  - 1. The SMS shall seamlessly interface with devices from the following manufacturers
    - a. Radionics / Bosch
    - b. Zenitel
    - c. Visonics
    - d. Honeywell
    - e. Osborne Hoffman
    - f. EST
    - g. Notifier
    - h. Pyrotronics

## 2.2 SMS SERVERS AND WORKSTATIONS

- A. Security Management System Server
  - 1. The SMS Server shall be 100% IBM Personal Computer Standard compatible, approved for use with Microsoft Windows 2008 R2 Server or Microsoft Windows XP Professional, and scaled according to the following system application requirements:
    - a. SMS Server shall consist of Dell PowerEdge 1850 or equivalent rack mountable server with the following salient features:
      - 1). Dual Intel 64-bit Xeon, 3.0 GHz, 800 MHz front side bus, 2 MB L2 cache processors
      - 2). 2 GB ECC DDR-2 SDRAM
      - 3). 24X IDE CD ROM
      - 4). 73GB Ultra 320 SCSI hard drive 10,000 rpm hard drive
      - 5). Broadcom NetXtreme 10/100/1000 NIC PCI Express Network Interface Card
      - 6). 17" SVGA Flat Monitor (1024 x 768)
      - 7). Integral Video Card
      - 8). 56K modem, (2) serial ports, (1) parallel port, audio with speakers, keyboard, mouse and surge suppression strip
      - 9). Rack mounted 1500 VA UPS
      - 10). 3 year limited warranty
- B. Security Management System Alarm Monitor/Client Workstation
  - 1. The SMS Client Workstation(s) shall be 100% IBM Personal Computer Standard compatible, approved for use with Microsoft Windows Server 2008 R2 and Microsoft

Windows 7 Professional, and scaled according to the following system application requirements:

- a. SMS Client Workstation shall consist of a Dell Optiplex GX520MT or equivalent business class workstation with the following salient features:
  - 1). Intel Pentium 4 630HT, 3.0 GHz, 800 MHz front side bus, 2 MB L2 cache processor
  - 2). 2 GB DDR-2 SDRAM
  - 3). 16XDVD+RW/+R 48X CD ROM
  - 4). 80GB SATA 7200 rpm hard drive
  - 5). Intel PRO 1000 Ethernet Network Interface Card
  - 6). 19" SVGA Flat Monitor (1024 x 768)
  - 7). Integral Video Card
  - 8). 56K modem, (2) serial ports, (1) parallel port, audio with speakers, keyboard, mouse and surge suppression strip
  - 9). Stand Alone 1500 VA UPS
  - 10). 3 year limited warranty

## 2.3 SMS FIELD HARDWARE

- A. Intelligent System Controller (ISC)
  1. The ISC shall be capable of communicating to the host computer in a single or dual-path configuration of Ethernet, dial-up or direct connect RS-485 communication. The ISC shall be capable of being configured with multiple combinations of Input Control Modules, Output Control Modules and Card Reader Interface Modules (up to 64 devices) using the two downstream RS-485 2-wire ports.
  2. The ISC is required to continue to function normally (stand-alone) in the event that it loses communication with the SMS software. While in this off-line state, the ISC shall make access granted/denied decisions and maintain a log of the events that have occurred. Events shall be stored in local memory, and then uploaded automatically to the SMS database after communication has been restored.
  3. In addition the ISC shall incorporate the following features:
    - a. On-board high-speed Ethernet 10/100Base-T.
    - b. Host dual path communication enabled - on-board Ethernet TCP/IP, direct wire (RS-485, 2-wire multidrop capable), or dial-up communications
    - c. 15 MB of available on-board, non-volatile flash memory
    - d. Battery-backed, non-volatile storage of 50,000 events
    - e. Firmware stored in flash memory, background download of firmware updates supported
    - f. 12 or 24 VDC input power
    - g. Up to 32,000 access level permissions
    - h. UL-294 listed and CE approved
  4. Acceptable manufacturer/model: Lenel LNL-3300
- B. Intelligent Single Door Controller (ISDC)
  1. The Intelligent Single Door Controller (ISDC) shall interface one or two readers to a single access door. The ISDC shall be an Ethernet ready card reader panel that controls a single opening with 802.3af compliant Power over Ethernet (PoE).
  2. The ISDC shall function independently of the host and be capable of sophisticated processes while controlling access for a single opening. Without host intervention, the ISDC shall be able to relate selected system devices and their activity to other onboard devices.
  3. In addition the ISDC shall incorporate the following features:
    - a. Primary Port: 10/100 Ethernet
    - b. Two reader ports: Magnetic stripe, Wiegand, or RS-485 (RS-485 on one reader port capable of supporting two readers)
    - c. Two fixed inputs for door contact and request to exit (REX)

- d. Two outputs; one dedicated for a strike and one general purpose (Form C, 2A @ 30Vdc)
  - e. 6 MB of available on-board, non-volatile flash memory
  - f. Firmware stored in flash memory, background download of firmware updates supported
  - g. 240,000 cardholders, 50,000 event transaction buffer
  - h. Up to 128 Access Levels per cardholder
  - i. UL-294 listed and CE approved
  - 4. Acceptable manufacturer/model: Lenel LNL-2210
- C. Intelligent Dual Reader Controller (IDRC)
- 1. The Intelligent Dual Reader Controller (IDRC) shall interface one or two doors to an OnGuard system. Additional I/O and reader interface modules shall be able to be added on the IDRC's downstream port.
  - 2. The IDRC shall be capable of storing up to 250,000 cardholders in non-volatile flash memory, and support selective download for larger cardholder databases. The IDRC shall be capable of connecting to up to 32 devices (maximum 64 doors) using the downstream RS-485 two-wire port.
  - 3. In addition the IDRC shall incorporate the following features:
    - a. On-board Ethernet 10/100Base-T port. DHCP and fixed IP addressing supported.
    - b. 6 MB of available on-board, non-volatile flash memory
    - c. Battery-backed, non-volatile storage of 50,000 events
    - d. Up to 32,000 access level permissions
    - e. 12 or 24 VDC input power
    - f. 4 Form-C relay outputs, 5 A at 30 VDC
    - g. Door contact supervision (open/closed) and REX push-button monitor for each door
    - h. On-board regulator to allow 12 VDC reader power from 24 VDC power source
    - i. UL 294 and 1076 listed and CE approved
  - 4. Acceptable manufacturer/model: Lenel LNL-2220
- D. Single Reader Interface Module (SRI)
- 1. The SRI shall provide a link between the Intelligent System Controller (ISC) and the card reader attached to the interface. Each SRI module shall be individually addressed.
  - 2. In addition the SRI shall incorporate the following features:
    - a. 12 or 24 VDC power supply
    - b. Two Form-C relay outputs (5 A door strike and 1 A aux)
    - c. Up to 16 different card formats (8 card formats and 8 asset formats)
    - d. Door contact open or closed, supervised or non-supervised
    - e. REX push-button monitor - supervised or non-supervised
    - f. Support for offline reader access mode
    - g. UL 294 and 1076 listed and CE approved
  - 3. Acceptable manufacturer/model: Lenel LNL-1300
- E. Dual Reader Interface Module (DRI)
- 1. The DRI shall provide a link between the Intelligent System Controller (ISC) and the card reader attached to the interface. The DRI shall include eight inputs that support normally open, normally closed, supervised, and non-supervised circuits. In addition, six output relays shall support fail-safe or fail-secure operation.
  - 2. In addition the DRI shall incorporate the following features:
    - a. 12 or 24 VDC power supply
    - b. Six Form-C 5 A at 30 VDC relay outputs
    - c. Up to 16 different formats (8 card formats and 8 asset formats)
    - d. Dedicated tamper and power failure circuits
    - e. Support for offline reader access mode
    - f. On-board regulator allows 12 VDC reader support from 24 VDC power source
    - g. UL 294 and 1076 listed and CE approved
  - 3. Acceptable manufacturer/model: Lenel LNL-1320

- F. Input Control Module (ICM)
  - 1. The Input Control Module shall communicate directly with the Intelligent System Controller (ISC) and provide 16 configurable input control points and 2 output control relays. It shall support normally open, normally closed, supervised and non-supervised circuits. The output relays shall be capable of being configured for fail-safe or fail-secure operation.
  - 2. In addition, the ICM shall incorporate the following features:
    - a. Grade B, A, and AA line supervision
    - b. 12 or 24 VDC input power
    - c. 16 programmable supervised or non-supervised contacts
    - d. 2 Form-C 5 A, 30 VDC contacts for load switching
    - e. 2 dedicated inputs for tamper and power failure status
    - f. RS-485 communication (2-wire or 4-wire RS-485)
    - g. UL 294 and 1076 listed and CE approved
  - 3. Acceptable manufacturer/model: Lenel LNL-1100
- G. Output Control Module (OCM)
  - 1. The Output Control Module shall communicate directly with the Intelligent System Controller (ISC) and provide 16 relay contacts for load switching. The relays shall be configurable for fail-safe or fail-secure operation.
  - 2. In addition, the OCM shall incorporate the following features:
    - a. 16 Form-C 5 A, 30 VDC contacts for load switching
    - b. 12 or 24 VDC input power
    - c. 2 dedicated digital inputs for tamper and power failure status
    - d. RS-485 communication, multidropped (2-wire or 4-wire RS-485)
    - e. Up to 16 OCMs per Intelligent System Controller
    - f. UL 294 and 1076 listed, CE approved
  - 3. Acceptable manufacturer/model: Lenel LNL-1100
- H. Local Alarm Horn
  - 1. Provide a horn at each access controlled portal requiring one as noted on the drawings.
    - a. Devices shall activate upon door alarm condition creating an audio indication of door alarm.
    - b. Devices shall be silenced remotely via the SMS or upon return of the portal to a secure state.
    - c. Upon acknowledgement of the alarm by the SMS operator the device shall reset.
  - 2. Horn indicator shall be low profile and shall be supplied with all mounting hardware.
    - a. The CONTRACTOR shall determine correct type of mount and back box for each horn device location.
  - 3. Acceptable manufacturer/model: Cooper Wheelock Model MT-12/24, no substitutions.

## 2.4 SMS SOFTWARE

- A. The SMS shall utilize a single seamlessly integrated relational database for all functions utilizing a fully multi-tasking multi-threading Microsoft Windows 7 or Windows Server 2008 Operating System.
- B. Upgrades or expansion of the SMS to a larger size system in scale shall not require installation of a different and/or new SMS application or require the administrator or operator to learn a different and or new interface from the previous version.
- C. The SMS shall be Microsoft Windows 7 Certified and shall have passed Microsoft-designed tests for compatibility and reliability on Windows 7.
- D. The SMS shall be UL 1076 Listed.
- E. The SMS shall only require a single license key to be present on the database server for the SMS to operate. The license key shall either be a physical device or a software license key.

- F. The SMS shall support concurrent licensing with respect to client licenses. Department shall purchase a fixed number of client workstation licenses (or connections) that shall be programmed into the database server license file. The SMS shall be installed on any number of client workstations in the Department facility. Then, any of the client workstations that have the SMS software installed shall have the ability to connect to the database server as long as the maximum number of concurrent connections purchased has not been reached. Connections shall be licensed on a per module basis. This shall provide Department with great flexibility in system design and layout.
- G. The SMS shall be able to seamlessly interface with and monitor intelligent system controllers, reader interface modules, I/O panels, alarm panels, alarm panel receivers, biometric devices, personal protection devices, intercom systems, fire alarm panels (secondary monitoring only), building management systems and digital video recorders approved for use by the SMS manufacturer.
- H. The SMS shall provide seamless integration with intrusion detection panels. This shall allow for the ability to monitor intrusion detection alarms in real time inside the SMS Alarm Monitoring module and allow for command and control of supported intrusion detection. Once alarms are brought into SMS, they shall have the ability to be linked to global I/O, and they shall be stored in the SMS database.
  - 1. The following intrusion detection panels shall be supported:
    - a. Bosch D9412 and D9412G;
    - b. Bosch D7412 and D7412g;
    - c. Detection Systems DS7400Xi and DS7400Xi Ver. 4+;
    - d. Honeywell Galaxy 8, 18, 60, 128, 500, 504, 512.
    - e. Honeywell Galaxy Dimension GD48, Honeywell Galaxy Dimension GD520
- I. The SMS shall be able to communicate with intelligent system controllers via RS-485, RS-232, TCP/IP or Ethernet, and dialup via modem.
- J. The SMS shall utilize an open architecture where all data must reside on a single database and must be accessible in real time to SMS workstation or Web-based client connected to the network. The system shall be configurable to support all of the following databases: Microsoft SQL Server 2008, Microsoft SQL Server 2005, Oracle Server 11g, and Oracle Server 10g. Oracle data may reside on Windows or UNIX platforms.
- K. The system architecture shall support Microsoft Windows Clustering, Hot Standby, Fault Tolerant Servers and Fault Tolerant Hot Standby Servers.
- L. Acceptable manufacturer/version(s):
- M. Choose one or more of the following based on the size of the system needed, they all have the same features otherwise.
  - 1. Lenel OnGuard<sup>®</sup> PRO Series: Large single site or small campus applications
    - a. Unlimited number of access control readers
    - b. Unlimited number of inputs or outputs
    - c. Unlimited number of client workstations
    - d. Unlimited number of cardholders.

## **2.5 SECURITY MANAGEMENT SYSTEM GRAPHICAL USER INTERFACE**

- A. The SMS shall be configured with a Graphical User Interface (GUI) as specified herein which minimizes training and operational needs for the operators. The software shall include on-line help displays to eliminate operator reference manuals. The GUI shall be an integral part of the SMS and is what SMS operators will use to interface with the SMS.
  - 1. The GUI shall represent each floor of the building separately.
  - 2. The GUI shall be zoned in accordance with the Drawings and shall operate such that if a glass break detector, motion sensor goes into alarm in a zone or if the Access Control System goes into alarm due to a door forced or door held open, the GUI will flash or

highlight a border around that zone and indicate whether a glass break detector or a motion sensor has gone into alarm.

3. The GUI shall utilize the same base maps as the GUI for the DVR System in accordance with Specification Section 27 05 24.
4. The GUI shall have different symbols for glass break detectors, motion sensors, CCTV cameras, and door contacts at a minimum.
5. Coordinate design of GUI base maps with the Department prior to final deployment and commissioning of system

## 2.6 ID BADGE PRINTER

- A. CONTRACTOR shall provide one ID Badge printers at locations shown on the Contract Drawings and one spare (total of two ID Badge Printers) with the following specifications and options:
  1. Print Method: Dye Sublimation/Resin Thermal Transfer
  2. Colors: 16.7 Million/256 Shades Per Area
  3. Resolution: 300dpi (11.8 dots/mm)
  4. Print Speed: 34 Seconds, Color with Lamination.
  5. Options:
    - a. Printer Cleaning Kit – One for each printer provided
    - b. HID iClass Smart Card Encoding Module
    - c. Dual Sided Printing
    - d. Ethernet with Internal Print Server
    - e. Card Lamination Module – Dual sided with Custom Hologram, CONTRACTOR to coordinate and develop hologram with the Department
- B. Contractor shall provide all required supplies, including ribbons and lamination, for the production of 500 dual sided ID badges.
- C. Acceptable Manufacturer/Model: Fargo Model DTC550, or approved equal.

## 2.7 ID BADGE PRODUCTION KIT

- A. Contractor shall provide one complete ID Badge Production kits with the following accessories:
  1. Blue Backdrop
  2. Lighting Kit
  3. Logitech QuickCam Orbit MP 1.3 Digital USB Camera, or approved equal.

## 2.8 INTRUSION DETECTION SYSTEM (IDS)

- A. The IDS specified herein shall include a Digital Alarm Communicator Transmitter (DACT), built-in telephone line monitor, up to 1000 event memory logger, real time clock, calendar, test timer, battery charging / voltage supervision circuitry, battery lead supervision, diagnostics displays, time / event-based scheduling system, lightning / EMI protection circuits, and the associated optional modules and components for a complete IDS.
- B. The DACT firmware shall support programmable "software" features as detailed below. The following describes the general functional requirements of the IDS:
  1. The IDS shall support the connection and reporting of intrusion devices to a remote Digital Alarm Communicator Receiver (DACR).
  2. The IDS shall provide identification, annunciation, and communication of alarmed detectors by point.
  3. The IDS shall be capable of segregating the points (i.e., a detector or group of detectors zoned together) into separate, independent "areas."
  4. The IDS shall be "modularly" expandable using hard-wired address identification modules.

5. The IDS shall have electrically supervised detection loops and power supplies (mains and battery(s)). This supervision shall be programmable for the purposes of reporting this information to the DACR.
  6. The IDS shall be capable of monitoring and switching to active telephone lines when trying to establish communications with the DACR and transmitting a report.
  7. The IDS shall be capable of reporting and communicating alarm or trouble event data by reporting to off-site remote DACRs via dial-up analog telephone lines or over a local or wide area network using a network interface module.
  8. The IDS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
  9. The IDS shall be programmable locally or remotely. Programming shall be accomplished via a portable programmer or a computer running the Remote Programming Software (RPS). Users shall be capable of changing their own user passcode from the Alarm Command Center (ACC) and managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
  10. The IDS shall annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English text at the ACC.
  11. The IDS shall be capable of executing diagnostics and testing functions locally or remotely.
  12. The IDS shall be capable of activating 128 relays and three additional outputs for auxiliary functions based on its classifications (area vs. panel wide).
  13. The IDS shall be capable of controlling relays and automatically executing system functions based on a time / event scheduling program. The program can be hour, day of week or day of month based. Each scheduled event can be exclusive of one of four holiday date definitions that can include one to 365 selected Julian dates. The following functions can be executed:
    - a. Arm / Disarm a specific area
    - b. Bypass / Unbypass a point
    - c. Activate / Deactivate a relay
    - d. Send a test report
    - e. Adjust system clock for daylight savings time
- C. System Feature/Capability Summary
1. The following indicates system software/hardware capabilities, capacities, and formats:
    - a. Number of Loops/Sensors: 246 separately identifiable points, of which 8 are on-board loops and 238 are off-board addressable points / zones connected to multiplexed backbone trunks. Each of the points shall be capable of supporting "group zoning." Group zoning refers to the combining of sensors into a separately identifiable and separately annunciated (programmable text) area.
    - b. Programming Point Functionality: Each point in the system shall provide for the following type of response in the system.
      - 1). Always on (24 hour response)
      - 2). On when the system is Master Armed
      - 3). Only on when the system is Perimeter Armed
      - 4). Displays / Does Not Display at the ACC when the point is activated
      - 5). Provides / Does Not Provide entry warning tone
      - 6). Sounds / Does Not Sound audible alarm indication
      - 7). The Point is bypassable / not bypassable
      - 8). Alarm Verification with programmable verification time
      - 9). Relay activation by Point
      - 10). Provides / Does Not Provide "watch point" capability
      - 11). Provides Swinger Bypass
      - 12). Defers Bypass Report
      - 13). Can return to the system after being force armed and then restoring
      - 14). Can return to the system after being bypassed and then restoring

- c. Areas/Accounts: The IDS shall support 8 independent areas. Each of the eight (8) areas shall have custom text associated with the armed state, disarmed state and point-off-normal state. Additionally, the IDS shall be capable of assigning 1 to 8 account identifiers to the areas depending on the distribution of areas per account. Each and all of the eight areas must be capable of Master and/or Perimeter arming (excluding predefined Interior protection).
- d. The IDS shall be capable of logically grouping 2 or more points into an area, or conversely, dividing the points into two or more areas.
- e. Any area shall be configurable to allow arming by specific users when a programmable number of devices are faulted or bypassed.
- f. Areas shall be independently controlled by their corresponding ACC. Each ACC can be designated to control a specific area, or group of areas, or all areas in the system.
- g. Independent control or relay functions by area shall be possible through programming assignments.
- h. Number of Alarm Command Centers: 32 Unsupervised ACCs, each capable of displaying custom English text on vacuum fluorescent displays and sounding different patterns of audible alarm for different events, shall be required. Up to Eight (8) ACCs can be supervised at one time. An ACC can be programmed to respond to the entry of any of the specifically authorized 250 user passcodes (followed by the [ENT] key) and cycle an assigned access control door using a connected door controller. The event is logged and transmitted (if routing is ON) to the DACR including door and user identity.
- i. Number of User Passcodes: Up to 249 different passcodes shall be required. Each passcode shall be three (3) to six (6) digits (variable) and be assigned a 16-character user name that shall be printed on the local printer and DACR with associated opening and closing reports from the user. Passcodes shall be enabled or disabled by area(s) and shall be assigned one of fourteen (14) different authority levels to carry out functions such as the activation of relays from the ACC. These passcodes shall also be required for carrying various system functions such as arming the system, disarming the system, transmitting a duress code, resetting the system and silencing sounders. A single user passcode shall be able to be used in each of the 8 areas with potentially a different authority level in each area.
- j. Each of the 249 different passcodes shall be able to be associated with 4 individual access cards/tokens. The authority of any of the four cards assigned to the user will be that of the user, but each card will report in the display, local printer, memory event log and at the DACR as a separate user / subuser number pair.
- k. Communication Formats: The Radionics Modem IIIa<sup>2</sup> communications format shall be utilized for optimum system performance. The DACT shall report to a Commercial Central Station using a Bosch Security Systems D6500 or D6600 Alarm Receiver that supports the Radionics Modem IIIa<sup>2</sup> communications format. One such advantage is point identification information transmission to DACRs (Alarms, Troubles and Restorals by point). Others include actual point number; point text; actual user number, user name; by-passed points; relay activation; opening/closing reports by users; late, early, or fail opening/closing reports, and opening/closing reports by area.
- l. Testing, Diagnostic, and Programming Facilities: Automatic test reports and remote system access for diagnostics, programming, and log (Logger) uploads shall also be supported via a remote central station computer utilizing the RPS software.
- m. Logger Capacities and Formats: Up to 1000 events indicating time, date, type of event, account number, area number, user ID, point text, user text and primary/secondary event route each event. Logs shall be viewed locally at the ACC and remotely via an upload to a computer running the RPS software. The IDS shall also support the printing of these events on up to three local printers. The IDS shall also send a report to the DACR when the log reaches a programmable "percent full

- capacity" so that RPS can retrieve the stored events. Group, signal type and area can rout events to specific printers.
- n. Reports: Reports to DACRs at commercial central stations as a result of system supervision shall include alarm, trouble, missing modules, restoral, system status, AC failure and low battery. The IDS shall also transmit test reports once every 24 hours. CPU failure shall be annunciated locally. The ACCs should display the following information for the indicated system supervisory conditions:
    - 1). Call for Service
    - 2). Service Panel
    - 3). Service Param
    - 4). Service AC Fail
    - 5). Service Battery Low
    - 6). Service Battery Missing
    - 7). Service Communications Failure
    - 8). Service Keypad
    - 9). Service Route
    - 10). Service Printer
    - 11). Service Point Buss Failure
  - o. Telephone Lines, IP Addresses, and "Phone Routing": The IDS shall support one (1) or two (2) telephone lines that are to be alternated for the transmission of consecutive events. The IDS shall have the capability of communicating with up to eight (8) different DACRs (4 different phone numbers) and/or four (4) different IP Addresses. Each Phone Number can be up to 24 digits long. The IDS reports shall be classified, by event, into eleven (11) subcategories or "report groups." Each group represents similar types of events. Individual events within each group shall be selectively enabled or disable to be transmitted. Each DACR shall be designated as a primary, backup, or duplicate destination for each report group. Assigning an event to multiple routing groups provides for duplicate destination for the event. The transmission of events allows the reporting of different types of information to different remote DACRs. The report groups shall be as follows:
    - 1). Burglar Reports
    - 2). User Reports
    - 3). Test Reports
    - 4). Diagnostic Reports
    - 5). Relay Reports
    - 6). Auto Function Reports
    - 7). RAM (RPS) Reports
    - 8). Point Reports
    - 9). User Change Reports
  - p. Number of Programmable Relay Output Modules: 8 relays (Form C) are to be provided per octo-relay module for a total of 128 relays plus three additional outputs per IDS. These multi-purpose modules are programmable and shall be used to implement auxiliary functions (manually or automatically).
  - q. Relays and other outputs may be programmed to follow up to 14 different area conditions or up to 12 panel conditions. Relays may also be programmed to follow individual points or groups of points.
  - r. Number and Alarm Output Selections: Four (4) different types of alarm output selections shall be supported by the IDS: Steady, Pulsed, California Standard, and Temporal Code 3.
  - s. The system can be configured to provide zoned indication of alarm conditions.
  - t. Miscellaneous Features: Programmable alarm output timer, 31 programmable entry delay times, exit delay programmable by area, individually programmable point of protection text, point bypassing, and keyswitch arming capability with LED outputs.
  - u. Real-Time Clock, Calendar, and Test Timer: The IDS shall incorporate an integral real-time clock, calendar, and a test timer.

- v. Opening and Closing Windows: The system shall be programmed with "normal" opening and closing periods for each day of the week and thus suppress scheduled opening / closing reports and report only the exceptions, i.e., opening / closing outside the pre-defined time window. The IDS shall have the capability to suppress opening / closing reports, overriding the programmed open / close windows during holidays and automatically arming the IDS (by area) at the end of the closing period.
  - w. IDS Power Ratings: The IDS shall provide 1.4 amps of auxiliary power and 2 amps of alarm power, both rated at 12 VDC.
  - x. IDS Fault Detection: The IDS shall check the point sensor loops once every 300 milliseconds. The point response time is programmable over a range of 300 milliseconds to 4.5 seconds.
  - y. User-Programmable Features: The IDS shall provide a menu driven interface to provide a user-friendly command structure for programming / customizing the system to the operational criteria of the application. The IDS shall be capable of being operated via:
    - 1). The Command Structure
    - 2). Menu / Command List
  - z. Shall be able to connect up to three parallel printers (D9412G) to the DACTS.
- D. IDS SYSTEM INTERFACE REQUIREMENTS
- 1. Grounding: The CONTRACTOR shall properly earth ground the IDS to prevent electrostatic charges and other transient electrical surges from damaging the IDS panel.
  - 2. Primary power: The CONTRACTOR shall provide a dedicated 120 VAC power circuit to the IDS system. This circuit shall be connected to the emergency power system. The 120 VAC is stepped down to 16.5 VAC to power the IDS panel using a class two, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.
  - 3. Primary power supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station. The transmission delay of this message is programmable from 5 seconds to 86 minutes with an optional 6 to 12 hour transmission delay. The message can also be programmed to "tag-along" with another message transmitted to the central station. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.
  - 4. Secondary power (standby battery): Provide adequate battery power as defined by the relevant application criteria, (UL 864 and 985 for alarm installations or NFPA 72 chapters for fire applications). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable MOA codes or MOA requirements must be met accordingly.
  - 5. Secondary power supervision: When the secondary power source experiences a 85% depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.
  - 6. Wiring: The CONTRACTOR shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
    - a. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.
    - b. All signal cables provided under this contract shall be Class II, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
    - c. Data wires shall not be enclosed in conduit or raceways containing AC power wires.
    - d. Where EMI may interfere with the proper operation of the IDS circuits, twisted/shielded cable shall be used.
  - 7. The IDS shall be protected from EMI and lightning surges.

8. Telephone interface: The IDS shall be equipped with a phone line monitor and shall interface with the phone lines via RJ-45 jacks for supervision of the telephone line connection to the IDS panel. When a telephone line is determined to be out of service by the IDS panel, the event will be annunciated locally on the ACC and transmitted to the central station. The transmission delay of this message is programmable from ten (10) to two-hundred forty (240) seconds. A telephone line switching modules shall be used to interface to a second telephone line. This interface shall conform with FCC rules part 15 and 68.
9. Ethernet access: The IDS may use an Ethernet interface module as the primary means of communicating to a DACR. Up to four IP Addresses shall be available to route system events to. A programmable supervision time of 5 to 65,535 seconds shall be required.
10. Auxiliary function control interfaces: Auxiliary functions such as activating bells, strobes, or lights shall be accomplished using the optional relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damages.
11. Functional criteria programmed into system memory shall be backed up by battery power. Additionally, the number of system programmers shall be severely restricted via the use of program locking features and passwords.

E. EQUIPMENT AND MATERIALS

1. System Hardware Description:
  - a. IDS: The IDS shall be provided, at minimum, with the following components. Additional accessories shall be provided based on the quantities and features required for the application.
    - 1). Enclosure
    - 2). Lock and key
    - 3). D9412G DACT with removable terminal blocks and single screw mounting bracket
    - 4). Faceplate shield and metal bracket covering rear of D9412G circuit assembly
    - 5). Power transformer
    - 6). Manuals
  2. The IDS control panel shall be Bosch Security Systems model D9412G.
    - a. System Accessories:
      - 1). -D125B-Class "B" loop module - Dual Powered loop interface module - two separate powered loops for 12 or 24 VDC, 2-wire devices
      - 2). -D130-Relay module 5 amps, Form C
      - 3). -D279A-Sub Zone Control
      - 4). -D55-Desk Stand
      - 5). -D56-Alarm Command Center surface conduit backbox
      - 6). -D8103-Universal enclosure
      - 7). -D811-Arm status relay module. Form C relay, activated based on information transmitted on the serial output
      - 8). -D8121A-Subscriber Terminal Unit (STU) - Works with Base Ten Telecom, Inc. VerSuS<sup>®</sup> derived-channel receiving system to provide alarm and critical event reporting as well as telephone line supervision
      - 9). -D8122-UL-listed version of D8121A
      - 10). -D8130-UL release module – designed for release applications commonly found in NFPA 72, chapter 6, fire alarm installations such as fire door release, elevator recall, emergency door unlock, stairwell pressurization, smoke exhaust control and HVAC control. Two independent Form C contacts, each rated at 5 amps. Multiple D8130s can be connected in parallel to a DACT.
      - 11). -D9002-5-Accessory Module Mounting Skirt
      - 12). -D9131A-Parallel Printer Interface Module – provides Centronics standard parallel output to be used for a parallel printer. 80 character format.
      - 13). -D9133-Serial Interface Module
      - 14). -D9133DC-Direct Connect Programming Module

- 15). -D9133TTL-E-Network Interface Module – provides connection to local or wide area networks to communicate system events to D6600 NetCom Receiver.
- 16). -D9412G-D9412G circuit board mounted on steel mounting skirt and literature pack
- 17). -DS150i-Request to Exit Detector
- 18). -DS7432-Eight Input Remote Module (MX2040)
- 19). -DS7450-Flush Mount Single Multiplex Contact Point
- 20). -DS7452-Surface Mount Single Multiplex Contact Point
- 21). -DS7457-Single Multiplex Input Module (MX2010 Intrusion)
- 22). -DS7460-Dual Input MUX Module (MX2020)
- 23). -DS7465-Input/Output Module (MX4010)
- b. Power Supply:
  - 1). -D122-Dual battery harness
  - 2). -D8004-UL transformer enclosure
  - 3). -D8132-UL - 12 V auxiliary battery charger. Combined with external batteries, increases standby time and provides additional power to auxiliary outputs of D9412GB.
- c. Communication Accessories:
  - 1). -D162-2 ft. (61 cm) phone cord
  - 2). -D166-RJ-31X Phone Jack
  - 3). -D928-Dual telephone line module – Alternates event transmission to Central Station between primary and secondary phone lines. Transmits over other phone line when first phone line is determined to be inoperable. Periodically tests phone line for usage and integrity and reports to central station when phone line is faulty. Remembers faulty line and transmits over operational line.
  - 4). -D9133TTL-E-Ethernet Interface Module
- d. Annunciation Devices:
  - 1). -D1255-Alarm Command Center (ACC) - Built-in multi-tone sounder. Displays status in custom English text on 16-character display. If more than 4 ACCs are required, add D8132 battery charger unit. ACCs provide "command menu" user interface. ACC can be supervised. Model D1255R for red color, D1255W for white.
- e. Programming
  - 1). -D5500C-XXXX-LTE-Remote Programming Software, Limited Programming Modules (RPS-Lite)
3. Initiating Devices
  - a. Acoustic Glass break Sensors:
    - 1). Sentrol #5812NT "ShatterPro 3" UL listed acoustic glass break sensor with 360° coverage pattern, adjustable 25-foot maximum coverage radius, Form A contacts, 12VDC input, and 2.75" x 4" rectangular white ABS housing designed to install on a single-gang box.
  - b. Motion Sensor
    - 1). GE Mirror Optic 360 Degree Dual Ceiling Mount, Model AP669 - UL Listed ceiling Mount PIR with From C relay, 8 foot - 16 foot mounting height.
  - c. Balanced Magnetic Switch (Door Contact)
    - 1). Balanced magnetic type switches signals door position.
    - 2). Device shall consist of two units mounted adjacent to each other in door and frame.
      - a) Switch unit: Doorframe mounted containing magnetic switch.
      - b) Magnet unit: Door mounted, containing permanent magnet.
    - 3). Acceptable manufacturer; Sentrol 2767 High Security or approved equal.
    - 4). Acceptable manufacturer for surface mount on fire rated wood doors - Securitron model number MSS-1G-RT or approved equal.
4. Intrusion Detection System (IDS) Test Equipment

- a. Laptop Computer
    - 1). At completion of Project turn over to DEPARTMENT one laptop computer capable of providing all field programming support of system. Unit shall be Dell Latitude D810 color system, or approved equal with the following features:
      - a) 2.26 Ghz, 2MB L2 Cache Pentium M Processor.
      - b) Fifteen inch WXGA Display.
      - c) 128MB Video Card.
      - d) 1 GB 533 Mhz DDR2 RAM.
      - e) 80GB Ultra ATA hard disk drive or higher.
      - f) 8X DVD+/-/RW
      - g) Internal 56 Kbps V.90 Fax Modem.
      - h) 802.11b/g WLAN card
      - i) 1.44 Mb, 3.5 inch floppy disk drive.
      - j) Sound Card.
      - k) Two Lithium-Ion Batteries (one spare), charger.
      - l) Windows XP Professional
      - m) Touchpad pointing device.
      - n) Soft Case.
  - b. Glass break Sensor Tester
    - 1). Product Description: Hand-held tester that generates glass break sounds to test glass break sensors.
5. Manufacturer: GE Model #5709C-W or approved equal.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install all equipment and materials in accordance with the recommendations of the manufacturer. The work shall also be in accordance with:
  - 1. Installation criteria defined in these specifications and in the Bid Documents.
  - 2. Approved Submittals.
  - 3. Applicable requirements of referenced standards.
- B. Install card readers where shown on the drawings.
- C. Locate controllers in accessible locations approved by the Department.
- D. All wiring shall be in concealed conduit.

#### **3.2 FIRE ALARM SYSTEM INTERFACE**

- A. Interface the SMS system specified herein with the Fire Alarm System provided under this Project to assist in the implementation of the Fire Alarm System Sequence of Operations as specified in Specification Section 28 31 13.
  - 1. An example of a typical interface required is reporting of the Fire Alarm System alarm/trouble status on the SMS Alarm Monitoring Workstation. Refer to Specification Section 28 31 13 for more specific requirements.

#### **3.3 INTRUSION DETECTION SYSTEM INTERFACE**

- A. Interface the SMS system specified herein with the Intrusion Detection System provided under this Project to assist in the implementation of the Intrusion Detection System Sequence of Operations.
  - 1. An example of a typical interface required is reporting of an Intrusion Detection event on the SMS Alarm Monitoring Workstation.

#### **3.4 DVRS SYSTEM INTERFACE**

- A. Interface the SMS system specified herein with the DVRS System provided under this Project to assist in the implementation of the DVRS System operations as specified in Specification Section 27 05 24.
  - 1. An example of a typical interface required is to automatically display real time video of a specific access control portal at the SMS Alarm Monitoring Workstation when that access control portal reports an unwanted event to the SMS. Refer to Specification Section 27 05 24 for more specific requirements.

### **3.5 BUILDING AUTOMATION SYSTEM INTERFACE**

- A. Interface the SMS system specified herein with the Building Automation System provided under this Project to assist in the implementation of the Building Automation System Sequence of Operations as specified in Specification Section 25 90 00.
  - 1. An example of a typical interface required is the turning on of corridor lights when the SMS goes into alarm due to the activation of a glass break detector. Refer to Specification Section 25 90 00 for more specific requirements.

### **3.6 DOOR HARDWARE AND DOOR OPERATION**

- A. Program the SMS system specified herein to implement the door (SMS access portal) Sequence of Operations as specified in Specification Section 08 71 00 for each particular door with SMS hardware specified as shown on the drawings or as detailed in that Specification. Refer to Specification Section 08 71 00 and the drawings for more specific requirements.
- B. Key Pad Time Override (KPTO)
  - 1. Where called for on the drawings, in the specifications, or in a schedule or where a card with an integral keypad (HID RK40) is provided, program the SMS to accept a Key Pad Time Override (KPTO) input where a valid card swipe allows the input of a valid code entry in the SMS via the card reader with integral key to tell the SMS to ignore a door held open for a specified length of time which is also keyed in via the card reader with integral keypad.

### **3.7 TESTING**

- A. Upon completion of the system installation, the CONTRACTOR shall notify the Department a minimum of 72 hours in advance, and functional testing shall be planned.
- B. The CONTRACTOR shall furnish all personnel, equipment, tools, software, means of communications, test instrumentation, and supplies necessary to perform all testing.
- C. The testing shall demonstrate the following:
  - 1. That the system in its entirety meets all requirements of the Contract Documents.
  - 2. That system equipment meets all requirements of the Contract Documents.
  - 3. That all system functions and operations meet all requirements of the Contract Documents.
- D. Each field-mounted device shall be tested via actual activation of the device under normal operating conditions rather than simulated activation.
- E. Where system testing will cause outages or impacts, schedule testing activities so as to impose the least inconvenience on system users. This may require that the CONTRACTOR schedule testing off shift in order to avoid conflicts with operations.
- F. All system and subsystems functionality and system integration and interfaces shall be 100 percent tested.

### **3.8 ADJUSTMENT, CORRECTION, AND COMPLETION**

- A. Make necessary adjustments and modification to the system.
- B. Correct deficiencies and retest affected components.

- C. If, during testing, the system fails to achieve the required standard for acceptance, the Contractor shall resubmit the system for testing after taking such remedial steps as necessary to correct the deficiency.

**3.9 SYSTEM ACCEPTANCE**

- A. System acceptance shall occur at the time of approval of the functional testing as determined by the Department. The warranty period shall begin from that date.

**3.10 DEMONSTRATIONS AND TRAINING**

- A. Each of the intended operations of the installed SMS shall be demonstrated to the Department by the Contractor.
- B. After the system provided in this Section is completely installed and operational, and at a time chosen by the Department, provide the Department's system operators and maintenance personnel with a total of eight (8) hours of instruction on the operation, maintenance, and troubleshooting of all equipment provided under this Section.
- C. Training sessions shall be presented by a fully qualified, trained representative of the equipment manufacturer, who is thoroughly knowledgeable on the specific installation. Separate sessions shall be given for operation personnel and maintenance personnel, with the length and content of the sessions tailored to the respective groups.
- D. Provide an additional two (2) hours of follow-up instruction for review and clarification at a later time mutually agreed on with the Department, if the Department deems it necessary.

**END OF SECTION 28 13 33**

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**SECTION 28 31 13**  
**ADDRESSABLE FIRE ALARM SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This specification provides the requirements for the installation, programming and configuration of a complete Addressable Intelligent Life Safety System Network for this project. The system shall include, but not limited to: Fire Alarm Control Panel(s), Automatic and Manually Activated Voice Evacuation Alarm Subsystem, Automatic and Manually activated alarm Initiating and Indicating Peripheral Devices and Appliances, conduit, wire and accessories required to furnish a complete and operational Life Safety System.

**1.2 SCOPE**

- A. Provide in operating condition an electrically operated, electrically supervised digital multiplexed fire alarm system as described herein. The system shall include, but not be limited to, control unit, power supplies, alarm initiating and indicating devices, conduit, conductors, fittings and accessories required to provide a complete operating system. All units shall be located in accordance with plans.

**1.3 REFERENCES**

- A. The equipment and installation shall comply with the current provisions of the following Codes and Standards:
1. National Electric Code, Article 760.
  2. National Fire Protection Association Standards:

NFPA 72	National Fire Alarm Code
NFPA 101	Life Safety Code

3. Local and State Building Codes.
  4. Local Authorities Having Jurisdiction.
  5. Underwriters Laboratories Inc.
- B. The system and all components shall be listed by Underwriters Laboratories Inc. for use in fire protective signaling system under the following standards as applicable:

UL 864/UOJZ, APOU	Control Units for Fire Protective Signaling Systems.
UL 268	Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	Smoke Detectors for Duct Applications.
UL 217	Smoke Detectors Single Station.
UL 521	Heat Detectors for Fire Protective Signaling Systems.
UL 228	Door Holders for Fire Protective Signaling Systems.
UL 464	Audible Signaling Appliances.
UL 1638	Visual Signaling Appliances.
UL 38	Manually Activated Signaling Boxes.
UL 346	Waterflow Indicators for Fire Protective Signaling Systems.
UL 1971	Standard for Signaling Devices for the Hearing Impaired.
UL 1481	Power Supplies for Fire Protective Signaling Systems.

UL 1711	Amplifiers for Fire Protective Signaling Systems.
UUKL	Smoke Control Equipment

- C. Americans with Disabilities Act (ADA).
- D. International Standards Organization (ISO).
  - 1. ISO-9000.
  - 2. ISO-9001.

#### 1.4 SYSTEM DESCRIPTION

- A. The Fire Alarm / Life Safety System supplied under this specification shall be a microprocessor-based network system. All Control Panel Assemblies and connected Field Appliances shall be provided by the same company, and shall be tested and cross-listed as compatible to ensure that a fully functioning Life Safety System is provided.

#### 1.5 QUALITY CONTROL

- A. Qualifications of Contractor
  - 1. The Contractor shall have successfully installed similar system fire detection, evacuation and visual signaling control components on a previous project of comparable size and complexity. The Department reserves the right to reject any control components for which evidence of a successful prior installation performed by the Contractor cannot be provided.
  - 2. The Contractor shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall:
    - a. Perform the detailed engineering design of central and remote control equipment.
    - b. Produce all panel and equipment drawings and Submittals, operating manuals.
    - c. Coordinate system installation requirements, and final system testing and Commissioning in accordance with these specifications.
  - 3. The installation of the system shall conform to the State of Alaska regulations.
  - 4. The Manufacturer shall be a nationally recognized company specializing in fire alarm systems and shall employ factory trained, NICET certified technicians. The Manufacturer shall maintain a service organization in Alaska and have a minimum of 5 years of experience in the fire alarm industry.
  - 5. The installer shall be a company specializing in the installation of fire alarm systems and be factory certified by the Manufacturer for their system. The installer shall have a minimum of 3 years of experience installing fire alarm systems. The installation shall be fully field verified by a factory trained and authorized technician and hold a NICET Level III certification.

#### 1.6 SUBMITTALS

- A. Provide Submittals for all products in accordance with Section 26 00 00 - Electrical General Requirements and Division 1.
- B. Submit for approval manufacturer's catalog information with complete description of all panel mounted and remote equipment.
- C. Include complete one-line risers and point-to-point wiring diagrams prepared especially for this installation.
- D. The supplier of the system shall provide conduit layout drawings of the system, indicating type, size and number of all conductors, conduits and junction boxes.
- E. Provide calculations verifying standby battery capacity per NFPA 72, including manufacturer's published current consumption data for all equipment on the System. Provide calculations verifying that notification appliance circuits voltage drops do not exceed the limits further specified in this Section.

- F. Provide calculations verifying that audio amplifier circuits are sized in accordance with this Section.
- G. DELETE ALL SUPERFLUOUS INFORMATION FROM SUBMITTAL DATA, SUCH AS MODEL NUMBERS AND OPTIONS FOR EQUIPMENT CONTAINED ON MANUFACTURER'S DATA SHEETS BUT NOT USED ON THIS PROJECT.
- H. Submit to the Authority Having Jurisdiction and obtain a written statement of Approval of the proposed system. This Approval shall be obtained prior to submitting to the Department.

#### **1.7 DEPARTMENT'S MANUALS**

- A. Furnish complete sets of Operation and Maintenance Manuals and other information necessary for the operation and maintenance of the system in accordance with Division 1 requirements. Provide number of sets as required in Division 1, however if not specified, provide a minimum of two (2) complete sets.

#### **1.8 WARRANTY AND SERVICE**

- A. Warrant all components, parts and assemblies against defects in materials and workmanship for a period of 12 months from date of final completion. Warranty service shall be provided by a trained specialist of the equipment manufacturer. The specialist shall be based in a fully-staffed branch office located within a reasonable distance from the job site.
- B. Service availability: The supplier shall have sufficient stock on hand and have a fully equipped service organization capable of guaranteeing response time within 2 hours of service calls, 24 hours a day, 7 days a week to service completed systems.
- C. The Engineered Systems Distributor of the Fire Alarm / Life Safety Equipment specified herein shall provide a copy of their certificate of successful completion of an authorized Training Course given by the Manufacturer of the Fire Alarm / Life Safety Equipment.

### **PART 2 - PRODUCTS**

#### **2.1 BASIS OF DESIGN**

- A. These specifications are based on equipment from Edwards System Technology (EST3) to set a standard for design and quality. Equipment manufactured by other manufacturers will be considered providing that sufficient documentation is provided to the Department that certifies that their equipment meets the requirements of these specifications.

#### **2.2 GENERAL**

- A. All equipment furnished for this project shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials, accessories, devices, and other facilities covered by this specification or noted on contract drawings and installation specifications shall be the best suited for the intended use and shall be provided by a single manufacturer. If any of the equipment provided under this Specification is provided by different manufacturers, then that equipment shall be recognized as compatible by both manufacturers, and "Listed" as such by Underwriters' Laboratories.
- B. System installation and operations shall be verified by the manufacturer's representative and a verification certificate presented upon completion. The manufacturer's representative shall be responsible for an on-site demonstration of the operation of the system and initial staff training as required by the Department.
- C. The system shall be capable of detecting the electrical location of each Signature intelligent device including new and existing devices. It shall be possible to display the intelligent device map on the laptop PC.
- D. It shall be possible for authorized service personnel using a Program/Service Tool or laptop PC to change the personality/function of a Signature Series Device to meet changes in

building layout or environment. System changes shall be verified by the manufacturer's representative and a verification certificate presented upon completion.

### 2.3 AUTOMATIC ALARM OPERATIONS

- A. Operation of each alarm input device shall show on the LCD display at the main Control Panel and each Remote Alphanumeric Display Annunciator(s). Each Intelligent device shall annunciate individually.
- B. LCD display messages shall be approved by the Authority Having Jurisdiction and the Department prior to equipment ordering and programming. Changes required by the AHJ or the Department shall be implemented without increase in the Contract Amount.
- C. The system shall be capable of displaying events by type (fire alarm, pre-alert, supervisory, and trouble). At the same time, the system shall sound a momentary audible signal for each event occurrence; flash an LED when an unacknowledged event exists, and, update the display to annunciate the total by type.
- D. Upon alarm, the system shall sound the evacuation signals throughout the building.
- E. The system shall display operational status of each signal circuit to inform the emergency user of the system status.
- F. Upon alarm, the system shall shut down air supply fans. Shutdowns shall be hardwired from the Fire Alarm System (i.e., not implemented via building automation controls) and immediate acting, and shall not be overridden by Hand-Off-Auto switches or other controls.
- G. Upon alarm, the system shall de-energize door holders to release fire doors. Provide separate circuit(s) as necessary for operation of all door holders. If door holders are 120VAC, circuits shall be from the same panelboard used to supply the fire alarm control panel. If door holders are 24V, circuits shall be from the fire alarm control panel using 120VAC to 24VAC transformers. Door holder circuits shall be fused as necessary to prevent damage to the Fire Alarm System. Submit for approval all proposed power sources prior to installation or connection of equipment.
- H. Overhead Doors: Provide local release only for overhead doors. Power roll down door release mechanism from battery backed-up fire alarm auxiliary power source.
- I. Upon alarm initiated by the sprinkler flow switch(es), the system shall sound the exterior sprinkler bell and sound the evacuation signals throughout the building. The sprinkler bell shall be supplied by a non-silenceable supervised notification circuit.
- J. Upon alarm, the system shall de-energize smoke dampers and smoke/fire dampers to close dampers. Provide a commandable relay for control of each damper.
- K. Upon alarm, the system shall effect the locking/unlocking of emergency exits connected to the building fire alarm system.
- L. Separate Alarm and trouble conditions shall be transmitted to the Building Control System (BCS). Common alarm, common trouble and common sprinkler alarm conditions shall be monitored by the BCS and Security Systems.

### 2.4 ELEVATOR RECALL

- A. The activation of a smoke sensor or detector in any elevator machine room, or associated lobby (other than on the Designated Level) shall cause the car(s) that serve that lobby to return nonstop to the Designated Level. If the smoke sensor or detector at the Designated Level is activated the car(s) shall return to an Alternate Level approved by the enforcing authority. (ANSI/ASME A17.1 RULE 211.3b.). Unless otherwise required by the Authority Having Jurisdiction, only the elevator lobby, elevator hoistway (if provided), and the elevator machine room smoke detectors shall initiate elevator recall for fire fighter's service.
- B. The activation of elevator hoistway (if provided) and elevator machine room smoke detectors shall cause separate and distinct visible annunciation at the control unit and required

annunciators to alert fire fighters and other emergency personnel that the elevators are no longer safe to use.

- C. Elevator Control Circuits:
1. Provide three separate elevator control relay circuits for each elevator. The elevator control circuits shall be terminated at their respective elevator controller in the elevator machine room(s). Operation of the elevators shall be in accordance with ANSI/ASME A17.1, Safety Code for Elevators and Escalators, Rules 211.3 through 211.8. Smoke detectors shall activate the three elevator control circuits as follows:
    - a. Control Circuit #1: Activation of the smoke detector at the Designated Level (designated elevator recall lobby) shall actuate the first elevator control circuit. If the elevator is equipped with front and rear doors, the smoke detectors in both lobbies at the designated level shall actuate Control Circuit #1.
    - b. Control Circuit #2: Activation of the smoke detectors in the remaining elevator lobbies shall actuate the second elevator control circuit.
    - c. Control Circuit #3: Activation of smoke detectors in elevator machine room(s) shall actuate the third elevator control circuit. Where the elevator machine room is located at the Designated Level, the elevator machine room smoke detector shall also actuate Control Circuit #1.

## 2.5 EQUIPMENT

- A. The Life Safety System shall be a Multi-Processor Based Network System designed specifically for Fire and Audio Evacuation applications. The Life Safety System shall be UL listed under Standards 864 (Control Units for Fire-Protective Signaling Systems) under categories UOJZ and APOU, and ULC listed under standard CAN/ULC-S527.
- B. The Life Safety System shall include all required hardware and system programming to provide a complete and operational system, capable of providing the protected premises with the following functions and operations:
  1. Modular systems design, with a layered application design concept, including an "Operational Layer" and a "Human Interface Layer," to allow maximum flexibility of the system with a minimum physical size requirement.
  2. Audio Paging and Emergency Evacuation subsystem with fully digitized and multiplexed audio. Up to 32 minutes of pre-recorded audio shall be transmittable over one of 8 audio channels over a single pair of wires. The system shall not require mechanical potentiometers to make adjustment of audio levels within the system.
  3. All System operational software shall be stored in FLASH memory. Control Panel disassembly, and replacement of electronic components of any kind shall not be required in order to upgrade the operations of the installed system to conform to future application code and operating system changes.
  4. Up to 128 Service Groups shall be definable within the system program to allow the testing of the installed system based on the physical layout of the system, not on the wiring of the field circuits connected to the Fire Alarm Control Panel.
  5. Advanced Windows™-based System Definition Utility with Program Version Reporting to document any and all changes made during system start-up or system Commissioning. Time and Date Stamps of all modifications made to the program shall be included to allow full retention of all previous program version data.
  6. System response to any alarm condition shall occur within 3 seconds, regardless of the size and the complexity of the installed system.
  7. System Common Control Functions shall be automatically routed to any node of the system as a function of the time of day and date.

## 2.6 THE LIFE SAFETY SYSTEM

- A. The Life Safety System shall include the following features and shall support the following operations in each installed cabinet or node of the system:

1. Up to 10 Signature Series Intelligent Device loops.
  2. Up to 125 Intelligent Smoke Detectors and 125 Intelligent Modules per Signature Device Card (SDC).
  3. Up to 120 Hardwired input/output Circuits.
  4. Up to 342 Manual Control (Input) Switches.
  5. Up to 456 LED Annunciation Points.
  6. Up to 63 Remote Display Units.
  7. Multi-Priority, token passing, peer-to-peer network connection of up to 64 system nodes wired as Class B (Style 4).
  8. Ground fault detection by panel, by Signature Data Circuit, and by device module.
  9. Ability to download all system applications programs and "firmware" from a computer through a single point in the system.
  10. True Distributed Intelligence, including microprocessor-based Detectors and Modules.
  11. A.C. Power Trouble Delay adjustable from 4 Hours to 10 Hours.
  12. Removable, Interlocked terminal blocks for the connection of the field wiring to the Fire Alarm Control Panel.
  13. Electronic Addressing of Field Devices.
  14. Advanced Power Management.
  15. Dead Front Construction.
- B. System Common Controls and Emergency User Interface: The Fire Alarm / Life Safety System shall include a Emergency Operators' Interface Panel which shall include the following system annunciation and control functions:
1. System Annunciation and Control Functions:
    - a. Hands free Emergency Operation. The first and last highest priority event on the system shall be displayed automatically and simultaneously.
    - b. Control Panel Internal Audible Signal shall have four programmable signal patterns, to allow for the easy differentiation between Alarm, Supervisory, Trouble and Monitor conditions within the installed system.
  2. Discrete "System Status" LEDs:
    - a. Power Status LED - Green LED shall illuminate when AC power is present.
    - b. Test Status LED - Yellow LED shall illuminate when any portion of the system is in the test mode. A programmable timer shall cause the system to automatically exit the test mode after a period of system inactivity. This Test LED shall function in a local or in a group mode.
    - c. CPU Fail Status LED - Yellow LED shall illuminate when the panel controller has an internal failure.
    - d. Ground Fault Status LED - Yellow LED shall illuminate when ungrounded wiring connected to the cabinets' power supply has continuity to ground. This feature shall function in either a local or group mode.
    - e. Disable Status LED - Yellow LED shall illuminate whenever any point or zone in the installed system is manually disabled.
  3. Discrete Common Control Switches with associated Status LEDs:
    - a. Reset: Depression of the Reset Switch shall start the system reset operation. The associated Yellow LED shall have three flash rates during this operation to inform the user of the progress status of the reset cycle. The LED shall flash fast during the smoke detector power down sequence, then it shall flash slowly during the restart phase, and shall illuminate steadily for the restoral phase. The LED shall go out completely when the system is back to normal mode. Each phase, as well the overall reset cycle shall be programmable to perform other functions.
    - b. Alarm Silence: Depression of the Alarm Silence Switch shall turn off all (audible and/or visible) Notification Appliance Circuits. The associated yellow LED illuminates when the Alarm Silence function is active, whether by the Alarm Silence Switch, or by an integral software timer. Subsequent activation of the Alarm Silence Switch shall resound the signals. Activation of the Alarm Silence switch shall be programmable to perform other functions.

- c. Panel Silence: Depression of the Panel Silence Switch shall turn off the systems' internal audible signal when configured as a 'local' system. The associated yellow LED illuminates when the panel silence feature is activated.
  4. Other Operator Control Switches:
    - a. Previous Message Switch: Pressing the Previous Message Switch shall scroll the display to show the preceding message in the selected queue. Holding the Previous Message Switch and pressing any queue select switch moves to the top of the respective queue event list. Scrolling through event messages may be done by the operator at any time.
    - b. Next Message Switch: Pressing the Next Message Switch shall scroll the display to show the following message in the selected queue. Holding the Previous Message Switch and pressing any queue select switch moves to the bottom of the respective queue event list. Scrolling through event messages may be done by the operator at any time.
    - c. More Details Switch: Pressing the More Details Switch shall show the address and 42 character location message of the active device on display. If a zone is active, pressing the switch displays the address and message of active devices within the zone. When multiple devices are active, the "Previous/Next" message switch may be used to scroll through the messages.
  5. The System Main Liquid Crystal Display: The Liquid Crystal display shall provide the means to inform the System Operator with detailed information about the off-normal status of the installed Fire Alarm / Life Safety System. The Main Display shall automatically respond to the status of the system, and shall display that status on a 24 line by 40 character backlit alpha-numeric Graphical Liquid Crystal Display. The following status functions shall be annunciated by the Main Liquid Crystal Display:
    - a. When the Fire Alarm / Life Safety System is in the "Normal" Mode, the LCD displays: The current Date and Time. A Custom System Title. A summary total of the Alarm History of the system.
    - b. With the Fire Alarm Life Safety System in the Alarm Mode, the LCD shall automatically reconfigure into four logical windows.
    - c. Systems Status Window: The LCD shall show the system time, and the number of active points and disabled points in the system in this section of the LCD Display.
    - d. Current Event Window: The LCD shall show the first active event of the highest priority in reverse text to highlight the condition to the Emergency Operator. The top line of the reversed text shall show the sequence number in which the displayed event was received, as well as its event type. The second and third lines of reversed text shall display an identification message related to the displayed event. The display is capable of displaying the next 6 alarm events in order of their occurrence and if there are more than seven active points the system will indicate the latest alarm point in the last viewing queue on the display. Allowing first responders to see where the alarm started, where it has traveled to and what the last alarm point is at a glance.
    - e. Last Event Window: The LCD shall show the most recent, highest priority event received by the system.
    - f. Type Status Window: The LCD shall show the total number of active events in the system, by event type. There shall be four different System Event Types which shall be displayed, "Alarm Events", "Supervisory Events", "Active Trouble Events", and "Active Monitor Events".
    - g. System Message Processing: In order to simplify, and to clarify the System Status information which is given to the Emergency Operator, the Main LCD shall include queues for each of the System Event Types. The Main LCD shall allow the Emergency operator access to the System Status information contained within those queues by pressing an associated queue select switch. Whenever there is an unacknowledged event in any of the System Event queues, the associated Status

- LED shall flash. Viewing each event listed in a queue shall acknowledge all events in that queue, and shall cause the associated LED to illuminate steady.
- h. All messages contained in any of the System Event queues shall be accessible for review by the Emergency Operator using the "Previous/Next" message switch. It shall be possible to route additional event information to a printer.
  - i. Maintenance Menu: The Main LCD shall also allow the System Operator to access system maintenance functions through a four level password system. The authorized System Operator shall be able to access the following functions:
    - 1). System Status: The system shall allow the operator to determine the status of individual system components, including active points, disabled points, and active points by panel.
    - 2). Enable: The system shall allow the operator to restore a disabled point (device) in the system, allowing that point (device) to operate as originally intended by the application program of the system. Additionally, the system shall allow the operator to restore any group function, Panel, system module, "software - defined zone", operator control, or time control function.
    - 3). Disable: The system shall allow the operator to disable any point (device) in the system, inhibiting that point (device) from operating as originally intended by the application program of the system. Additionally, the system shall allow the operator to disable any group function, Panel, system module, "software - defined zone", operator control, or time control function within the system.
    - 4). Activate: The system shall allow the operator to manually turn on any system output point, or system function. Alternate Smoke Detector sensitivity, message routing within the system and check-in group timings shall be modifiable with this simple command from the control panel.
    - 5). Restore: The system shall allow the operator to restore the primary (application program defined) operation to the Smoke Detector sensitivity and the message routing functions with this simple command from the control panel.
    - 6). Control Output: The system shall allow the operator to manually command and control relays and LEDs. Relays shall be able to be commanded to "Latch", to energize as a "High Priority", or as a "Low Priority", to "Energize", or to "De-Energize".
    - 7). LEDs shall be able to be commanded to "Latch", to energize as a "High Priority", or as a "Low Priority", to turn "On", to turn "Off", to "Slow Blink", or to "Fast Blink".
    - 8). The system shall provide the operator with system reports which give detailed description of the status of certain system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the Main LCD, and shall be capable of being printed on any of the connected system printers.
    - 9). The system shall provide a report which gives a sensitivity listing of all detectors which have less than 75% environmental compensation remaining.
    - 10). The system shall provide a report which provides a sensitivity listing of any particular detector.
    - 11). The system shall provide a report which gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given SDC loop within any given panel.
    - 12). The system shall provide a report which gives a chronological listing of up to the last 1740 system events.
    - 13). The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.
  6. Program: The system shall allow the authorized operator to perform all of the following system functions:

- a. Set the System Time.
  - b. Set the System Date.
  - c. Set (Change) the System Passwords.
  - d. Restart the System.
  - e. Set the Dates for the System Holiday Schedule.
  - f. Clear the Chronological System History File.
7. Test: The system shall allow the authorized operator to perform test functions within the installed system. Test functions shall be defined by the authorized operator to be performed on a per cabinet, circuit, or service group basis.
- C. Local Control and Display Annunciators:
1. Each panel in the installed system shall include local Control and Display Annunciators. These annunciators shall have integral membrane style, tactile push-button control switches, for the control of system functions, and LEDs with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events.
- D. Remote System Display (Point) Annunciators:
1. Each remote display annunciator panel in the installed system shall include remote Control and Display Annunciators. These annunciators shall have integral membrane style, tactile push-button control switches for the control of system functions, and LEDs with programmable (software-controlled) flash rates and slide-in labels for annunciation of system events. Coordinate specific control functions to be provided at each display annunciator with the Department.
- E. Life Safety System Operations Interface:
1. SDC Card: The Signature Device Card (SDC) shall be the interface between the Fire Alarm Control Panel and the Signature Series Detectors and Modules. The communications format between the SDC and the Signature Series Devices shall be 100% digital. Communications to devices shall incorporate BROADCAST POLLING and DIRECT ADDRESS SEARCH to ensure the fastest reporting of off-normal conditions to the system human interface layer.
  2. It shall be possible to wire the SDC as Class A (Style 6 or Style 7) or Class B (Style 4) without twisted or shielded wire. It shall be possible to wire branch circuits (T-Taps) from Class B Circuits.
  3. The associated controller (3-SSDC), through the SDC, shall provide the ability to set the sensitivity and alarm verification of each of the individual intelligent detectors on the circuit. It shall be possible to automatically set the sensitivity of individual intelligent detectors during day and night periods.
  4. It shall be possible for the SDC to address all intelligent devices connected to it without having to set switches at the individual devices.
  5. It shall be possible to obtain a mapping report of all devices connected to the circuit for confirmation of "as-built" wiring. The map shall show physical wiring of T-Taps, device types, and the panel addresses of devices connected to the circuit. The SDC shall be capable of reporting unexpected additional device addresses and changes to the wiring in the data circuit. A specific trouble shall be reported for any off-normal non-alarm condition.
  6. The SDC shall be able to report the following information on a per intelligent device basis:
    - a. Device Serial Number.
    - b. Device Address.
    - c. Device Type.
    - d. Current Detector Sensitivity Values and the Extent of Environmental Compensation.
    - e. Any of 32 possible trouble codes to specifically diagnose faults.
  7. Should a Signature Driver Controller CPU fail to communicate, the Signature circuit shall go into the stand-alone mode. The circuit shall be capable of producing a loop alarm if an alarm type device becomes active during stand-alone mode.

- F. Hard Wired NAC Circuits:
1. Provide where indicated on the plans supervised hard-wired Notification Appliance Circuits (NAC) for the control of 24Vdc EST Genesis Series Signaling Appliances. The NAC shall be wired Class B (Style Y).
- G. Life Safety System Programmable Operations: System Message Processing and Display Operations.
1. The Fire Alarm / Life Safety System shall allow Network Routing to be configured to any or all nodes (cabinets) in the network.
  2. All of the system Printer ports can be configured to display any or all of the following functions:
    - a. Alarm.
    - b. Supervisory.
    - c. Trouble.
    - d. Monitor.
    - e. Service Group.
  3. Each LCD Display on each node (cabinet) in the system shall be configurable to show the status of any or all of the following functions anywhere in the system:
    - a. Alarm.
    - b. Supervisory.
    - c. Trouble.
    - d. Monitor.
  4. The system shall provide the capability to label each of the system points with up to 256 characters of location message. The first 42 characters shall be directed to the LCD while the entire message shall be sent to the printer.
  5. The system shall have the capability to provide up to 128 logical Counting AND Groups. Each group shall have a programmable 'activation' number. Whenever the number of active devices in an AND Group reaches the activation number, the AND Groups' rules will execute. It shall be possible to 'overlap' AND groups by having devices appear in more than one group.
  6. The system shall have the ability to define a minimum of 128 Matrix Groups with up to 250 points each. For each matrix, it shall be possible to define a 'radius' and an 'activation' number. The radius number defines the proximity between detector locations. When two detectors activate at or within the value of the 'radius' or whenever the number of active devices reaches the activation number the Matrix Group activates. It shall be possible to 'overlap' Matrix groups by having devices appear in more than one group.
  7. The system shall include the ability to define an alternate set of device commands which may be used in combination with the system test command for the testing of the connected Signature Series Smoke Detectors. This function shall disable the normal alarm command for each of the members of the group, so that the testing process will not result in an activation of the building evacuation signals, auxiliary relays or central station connections.
  8. The system shall include Time Control functions which will have the ability to control any system output or function, or initiate any system operational sequence as a function of the Month, Day of Week, Date, Hour, Minute, or Holiday.
  9. The system shall include up to 600 software defined Logical Zone Groups which may group any input from any Signature Data Circuit, or other Initiating Device Circuit, in order to control a system output or function, or initiate any system operational sequence. A device or IDC may be a member of one Logical Zone Group. Each of these zones shall have an associated message.
  10. The system shall provide the ability to download data from the Signature Series Detectors to a PC while the system is on-line and operational in the protected premises. The downloaded data may then be analyzed in a diagnostic program supplied by the system manufacturer.

H. Integrated Audio:

1. The Fire Alarm / Life Safety System shall incorporate a true digital integrated audio system into the network, multiplexing 8 independent audio channels over a single pair of wires. The system shall include distributed audio amplifiers. Provide sufficient amplifiers to power system speakers at maximum rated capacity of connected speakers, with minimum 20% spare capacity.
2. The system shall provide a local temporal back up tone at each amplifier to allow evacuation signals to be broadcast in the protected premises in the event of a loss of data communication from the multiplexed audio riser.
3. A digital message unit shall be provided which provides up to 32 minutes of pre-recorded emergency messaging. The message contained in the fully digital message unit shall be recordable in the field on a computer.

I. Audio Source Unit (3-ASU):

1. The Fire Alarm / Life safety System shall be provided with a fully integrated Emergency Communications System. The Emergency Communications System shall include a paging microphone, digital message playback unit, and 8 fully digitized and multiplexed Audio Channels. Four dedicated page mode control switches shall provide the emergency operator with instantaneous one touch paging to safely control the staged evacuation of building occupants. Automatic programming shall dynamically group the most frequently targeted paging zones.
2. The "All Call" switch will direct the manual page to the entire facility.
3. The "Page to Evac" switch will direct the manual page to those building areas automatically receiving the Evacuation Signal.
4. The "Page to Alert" switch will direct the manual page to those building areas automatically receiving the Alert Signal.
5. The "All Call Minus" switch will direct the manual page to those building areas which are programmed to receive the auxiliary and general channel connections such as stairwells.
6. The system shall have paging control switches and LEDs to support specific zone selection as shown on the plans. The zone control / displays shall confirm amplifier selection and annunciate amplifier and amplifier circuit trouble.
7. The system shall automatically deliver a pre-announce tone of 1000 Hz for three seconds when the emergency operator presses the microphone talk key. A 'ready to page' LED shall flash during the preannounce and turn steady when the system is ready for the user's page delivery.
8. The system shall include a page deactivation timer that activates for 3 seconds when the emergency user releases the microphone talk key. Should the user subsequently press the microphone key during the deactivation period a page can be delivered immediately. Should the timer complete its cycle the system shall automatically restore emergency signaling and any subsequent paging will be preceded by the pre-announce tone. A VU display shall display voice level to the emergency operator.

J. Audio Amplifiers:

1. Each audio power amplifier shall have integral audio signal de-multiplexers, allowing the amplifier to select any one of eight digitized audio channels. The system software shall direct the channel selection. Up to 8 multiple and different audio signals must be able to be broadcast simultaneously from the same system network node.
2. Each amplifier output shall include a dedicated, supervised 25/70 Vrms speaker circuit that is suitable for connection of emergency speaker appliances. Each amplifier shall also include a notification appliance circuit rated at 24Vdc @ 3.5A for connection of visible (strobe) appliances. This circuit shall be fully programmable and it shall be possible to define the circuit for the support of audible, visible, or ancillary devices.
3. Standby Audio amplifiers shall be provided that automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier.

4. In the event of a total loss of audio data communications, all amplifiers will default to the local "EVAC" tone generator channel. If the local panel has an alarm condition, then all amplifiers will sound the EVAC signal on their connected speaker circuits.
  5. In the event of a loss of the fully digitized, multiplexed audio riser, the audio amplifiers shall automatically default to an internally generated alarm tone that shall be operated at a 3-3-3 temporal pattern.
  6. Audio amplifiers shall automatically detect a short circuit condition on the connected speaker circuit wiring, and shall inhibit itself from driving into that short circuit condition.
- K. Remote microphones: Provide one remote microphone Model 3-REMICP at each panel.

## 2.7 INTELLIGENT DETECTORS

- A. The System Intelligent Detectors shall be capable of full digital communications using both broadcast and polling protocol. Each detector shall be capable of performing independent fire detection algorithms. The fire detection algorithm shall measure sensor signal dimensions, time patterns and combine different fire parameters to increase reliability and distinguish real fire conditions from unwanted deceptive nuisance alarms. Digital filters shall eliminate signal patterns that are not typical of fires. Devices not capable of combining different fire parameters or that do not employ digital filters shall not be acceptable.
- B. Each detector shall have an integral microprocessor capable of making alarm decisions based on fire parameter information stored in the detector head. Distributed intelligence shall improve response time by decreasing the data flow between detector and Analog loop controller. Detectors not capable of making independent alarm decisions are not acceptable. Maximum total Analog loop response time for detectors changing state shall be 0.5 seconds.
- C. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.
- D. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient "Environmental Thresholds" approximately six times an hour. The microprocessor shall continually monitor the environmental impact of temperature, humidity, other contaminants as well as detector aging. The process shall employ digital compensation to adapt the detector to both 24 hour long-term and 4 hour short-term environmental changes. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% and 100% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the "learned" base line sensitivity. The base line sensitivity information shall be updated and permanently stored at the detector approximately once every hour.
- E. The intelligent Analog device and the Analog loop controller shall provide increased reliability and inherent survivability through intelligent Analog standalone operation. The device shall automatically change to standalone conventional device operation in the event of a loop controller polling communications failure. In the Analog standalone detector mode, the Analog detector shall continue to operate using sensitivity and environmental compensation information stored in its microprocessor at the time of communications failure. The Analog loop controller shall monitor the loop and activate a loop alarm if any detector reaches its alarm sensitivity threshold.
- F. Each Signature Series device shall be capable of automatic electronic addressing and/or custom addressing.
- G. The intelligent Analog detectors shall be suitable for mounting on any Signature Series detector-mounting base.
  1. Fixed Temperature Heat Detector, SIGA-HFS: Provide intelligent fixed temperature heat detectors (SIGA-HFS). The heat detector shall have a Low Mass thermistor heat sensor

- and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The heat detector shall have a nominal alarm point rating of 135°F (57°C). The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and be suitable for wall mount applications.
2. Photoelectric Smoke Detector, SIGA-PS Provide intelligent photoelectric smoke detectors (SIGA-PS). The analog photoelectric detector shall utilize a light scattering type photoelectric smoke sensor to sense changes in air samples from its surroundings. The integral microprocessor shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, aging and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. The photo detector shall be rated for ceiling installation at a minimum of 30 ft (9.1m) centers and be suitable for wall mount applications. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The photo detector shall be suitable for operation in the following environment:
    - a. Temperature: 32°F to 120°F (0°C to 49°C).
    - b. Humidity: 0-93% RH, non-condensing.
    - c. Elevation: no limit.
  3. 4D Multisensor Detector, SIGA-IPHS: Provide intelligent 4D multisensor smoke detectors (SIGA-IPHS). The multisensor analog detector shall use a light scattering type photoelectric smoke sensor, a unipolar ionization smoke sensor and an ambient temperature sensor to sense changes in air samples from its surroundings. The integral microprocessor shall employ time-based algorithms to dynamically examine values from the three sensors simultaneously and initiate an alarm based on that data. The 4D Multisensor shall be capable of adapting to ambient environmental conditions. The temperature sensor shall self-adjust to the ambient temperature of the surrounding air and input an alarm when there is a change of 65°F (35°C) in ambient temperature. Systems using central intelligence for alarm decisions shall not be acceptable. The detector shall continually monitor any changes in sensitivity due to the environmental affects of dirt, smoke, temperature, age and humidity. The information shall be stored in the integral processor and transferred to the analog loop controller for retrieval using a laptop PC or the SIGA-PRO Signature Program/Service Tool. Separately mounted photoelectric detectors, ionization detectors and heat detectors in the same location are not acceptable alternatives. The 4D Multisensor smoke detector shall be rated for ceiling installation at a minimum of 30-ft (9.1m) centers and suitable for wall mount applications. The percent smoke obscuration per foot alarm set point shall be field selectable to any of five sensitivity settings ranging from 1.0% to 3.5%. The integral heat sensor shall cause an alarm when it senses a change in ambient temperature of 65°F (35°C) or reaches it fixed temperature alarm set point of 135°F (57°C) nominal. The 4D Multisensor detector shall be suitable for operation in the following environment:
    - a. Temperature: 32°F to 100°F (0°C to 38°C).
    - b. Humidity: 0-93% RH, non condensing.
    - c. Elevation : Up to 6,000 ft (1828 m).
  4. Standard Detector Mounting Bases, SIGA-SB / SIGA-SB4: Provide standard detector mounting bases (SIGA-SB or SIGA-SB4 as required). The base shall, contain no electronics, support all Signature Series detector types and have the following minimum requirements:
    - a. Removal of the respective detector shall not affect communications with other detectors.

- b. Terminal connections shall be made on the room side of the base. Bases that must be removed to gain access to the terminals shall not be acceptable.
- c. The base shall be capable of supporting one (1) Signature Series (SIGA-LED) Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.
5. Relay Detector Mounting Bases, SIGA-RB / SIGA-RB4: Provide relay detector mounting bases (SIGA-RB or SIGA-RB4 as required). The relay base shall support all Signature Series detector types and have the following minimum requirements:
  - a. The relay shall be a bi-stable type and selectable for normally open or normally closed operation.
  - b. The position of the contact shall be supervised.
  - c. The detector processor upon power up shall exercise the relay operation.
  - d. The relay shall automatically de-energize when a detector is removed.
  - e. Its respective detector processor shall control the operation of the relay base. Detectors operating standalone mode shall operate the relay upon changing to alarm state. Relay bases not controlled by the detector microprocessor shall not be acceptable.
  - f. Form "C" Relay contacts shall have a minimum rating of 1 amp @ 30 Vdc and be listed for "pilot duty".
  - g. Removal of the respective detector shall not affect communications with other detectors.
  - h. Terminal connections shall be made on the room side of the base. Bases that must be removed to gain access to the terminals shall not be acceptable.
6. Duct Detector, SIGA-SD: Provide smoke detector duct assemblies (SIGA-SD). Provide for variations in duct air velocity between 300 and 4000 feet per minute. Protect the measuring chamber from damage and insects. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Provide drilling templates and gaskets to facilitate locating and mounting the housing. Provide remote alarm test station (SIGA-TRK) as shown on the plans or if required by the installation.

## 2.8 INTELLIGENT MODULES

- A. It shall be possible to address each Intelligent Signature Series module without the use of DIP or rotary switches. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. Modules requiring EPROM, PROM, ROM changes or DIP switch and/or jumper changes shall not be acceptable. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes that can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults. The module shall be suitable for operation in the following environment:
  1. Temperature: 32°F to 120°F (0°C to 49°C).
  2. Humidity: 0-93% RH, non-condensing.
- B. Single Input Module, SIGA-CT1:
  1. Provide intelligent single input modules (SIGA-CT1). The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The single input module shall support the following circuit types:
    - a. Normally-Open Alarm Latching (Manual Fire Alarm Boxes, Heat Detectors, etc.).
    - b. Normally-Open Alarm Delayed Latching (Waterflow Switches).
    - c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.).
    - d. Normally-Open Active Latching (Supervisory, Tamper Switches).

- C. Dual Input Module, SIGA-CT2:
  - 1. Provide intelligent dual input modules (SIGA-CT2). The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The dual input module shall support the following circuit types:
    - a. Normally-Open Alarm Latching (Manual Fire Alarm Boxes, Heat Detectors, etc.).
    - b. Normally-Open Alarm Delayed Latching (Waterflow Switches).
    - c. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.).
    - d. Normally-Open Active Latching (Supervisory, Tamper Switches).
- D. Monitor Module, SIGA-MM1:
  - 1. Provide intelligent monitor modules (SIGA-MM1). The Monitor Module shall be factory set to support one (1) supervised Class B Normally-Open Active Non-Latching Monitor circuit.
- E. Waterflow/Tamper Module, SIGA-WTM or SIGA-CT2:
  - 1. Provide intelligent waterflow/tamper modules (SIGA-WTM, CT2). The Waterflow/Tamper Module shall be factory set to support two (2) supervised Class B input circuits. Channel A shall support a Normally-Open Alarm Delayed Latching Waterflow Switch circuit. Channel B shall support a Normally-Open Active Latching Tamper Switch.
- F. Single Input Signal Module, SIGA-CC1:
  - 1. Provide intelligent single input signal modules (SIGA-CC1). The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The single input signal module shall support the following operations:
    - a. Audible/Visible Signal Power Selector (Polarized 24 VDC @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio).
    - b. Telephone Power Selector with Ring Tone (Fire Fighters Telephone).
- G. Dual Input Signal Module, SIGA-CC2:
  - 1. Provide intelligent dual input signal modules (SIGA-CC2). The Dual Input (Dual Riser Select) Signal Module shall provide a means to selectively connect one of two (2) signaling circuit power risers to one (1) supervised output circuit. The dual input signal module shall support the following operation:
    - a. Audible/Visible Signal Power Selector (Polarized 24 VDC @ 2A, 25 Vrms @ 50w or 70 Vrms @ 35w of Audio).
- H. Control Relay Module, SIGA-CR:
  - 1. Provide intelligent control relay modules (SIGA-CR). The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.
- I. Universal Class A/B Module, SIGA-UM:
  - 1. Provide intelligent class A/B modules (SIGA-UM). The Universal Class A/B Module shall be capable of a minimum of fifteen (15) distinct operations. The universal class A/B module shall support the following circuit types:
    - a. Two (2) supervised Class B Normally-Open Alarm Latching.
    - b. Two (2) supervised Class B Normally-Open Alarm Delayed Latching.
    - c. Two (2) supervised Class B Normally-Open Active Non-Latching.
    - d. Two (2) supervised Class B Normally-Open Active Latching.
    - e. One (1) form "C" dry relay contact rated at 2 amps @ 24 VDC.
    - f. One (1) supervised Class A Normally-Open Alarm Latching.
    - g. One (1) supervised Class A Normally-Open Alarm Delayed Latching.
    - h. One (1) supervised Class A Normally-Open Active Non-Latching.
    - i. One (1) supervised Class A Normally-Open Active Latching.

- j. One (1) supervised Class A 2-wire Smoke Alarm Non-Verified.
- k. One (1) supervised Class B 2-wire Smoke Alarm Non-Verified.
- l. One (1) supervised Class A 2-wire Smoke Alarm Verified.
- m. One (1) supervised Class B 2-wire Smoke Alarm Verified.
- n. One (1) supervised Class A Signal Circuit, 24Vdc @ 2A.
- o. One (1) supervised Class B Signal Circuit, 24Vdc @ 2A.

## 2.9 INTELLIGENT MANUAL FIRE ALARM BOX

- A. It shall be possible to address each Signature Series fire alarm box without the use of DIP or rotary switches. The manual fire alarm box shall have a minimum of 2 diagnostic LEDs mounted on their integral, factory assembled single or two stage input module. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The manual fire alarm box shall be capable of storing up to 24 diagnostic codes that can be retrieved for troubleshooting assistance. Input circuit wiring shall be supervised for open and ground faults. The manual fire alarm box shall be suitable for operation in the following environment:
  - 1. Temperature: 32°F to 120°F (0°C to 49°C).
  - 2. Humidity: 0-93% RH, non-condensing.
- B. Double Action Manual Fire Alarm Box, SIGA-278:
  - 1. Provide intelligent double action, single stage manual fire alarm box (SIGA-278). The manual fire alarm box shall be of Lexan construction with an internal toggle switch. Provide a key locked test feature. Finish the manual fire alarm box in red with white "PULL IN CASE OF FIRE" lettering.
- C. Manual Fire Alarm Box Covers:
  - 1. Provide manual fire alarm box cover, STI "Stopper II", over each manual fire alarm box, unless otherwise noted. They shall consist of a tamper-proof; clear Lexan polycarbonate shield and frame suitable for mounting over flush-mounted or surface-mounted manual fire alarm boxes.

## 2.10 CONVENTIONAL FIRE ALARM INITIATING DEVICES

- A. Open Area Smoke Imaging Detection (OSID), Xtralis OSI-10
  - 1. Provide dual wavelength (IR and UV) open area smoke imaging detectors. The smoke imaging detectors shall be four wire 24 VDC and powered from a control panel 4 wire smoke power source. This complete unit shall consist of a separate imager and emitter capable of being powered separately or together. This unit shall operate at up to 150 meters (492 feet).
  - 2. The open area smoke imaging detectors shall feature three levels of alarm sensitivity; Low, Medium, and High. Ceiling or wall mount as shown on the Drawings.

## 2.11 NOTIFICATION APPLIANCES

- A. General
  - 1. All appliances shall be U.L. Listed for Fire Protective Service.
  - 2. All strobe appliances or combination appliances with strobes shall be capable of providing the "Equivalent Facilitation" which is allowed under the Americans with Disabilities Act Accessibilities Guidelines (ADA(AG)), and shall be UL 1971, and ULC S526 Listed.
  - 3. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to ensure absolute compatibility between the appliances and the control panels, and to ensure that the application of the appliances are done in accordance with the single manufacturers' instructions.
  - 4. Any appliances that do not meet the above requirements, and are submitted for use shall show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers which clearly states that their

- equipment (as submitted) are 100% compatible with each other for the purposes intended.
5. Initial settings for all devices with field selectable settings shall be set in accordance with the values indicated on the Drawings. Values shall be included on the Shop Drawing and As-built Drawing Submittals.
- B. Synchronized Strobes
1. All strobes shall flash at a rate of one flash per second and shall be synchronized indefinitely within 10 milliseconds of other strobes per UL 1971 Standard.
  2. Indoor Wall Mounted Strobes, Genesis Series: Provide strobes manufactured by EST. In - Out screw terminals shall be provided for wiring. The strobes shall have a white face plate. They shall provide field configurable 15 cd, 30 cd, 75 cd or 110 cd synchronized flash outputs as required by the application. The strobe shall have lens markings oriented for wall mounting.
  3. Indoor Ceiling Mounted Strobes, Genesis Series: Provide strobes manufactured by EST. In - Out screw terminals shall be provided for wiring. The strobes shall have a white face plate. They shall provide field configurable 15 cd, 30 cd, 75 cd or 95 cd synchronized flash outputs as required by the application. High output strobes shall provide field configurable 95 cd, 115 cd, 150 cd or 177 cd synchronized flash outputs as required by the application
- C. Horn/Strobes
1. All horn/strobes shall flash at a rate of one flash per second and shall be synchronized indefinitely within 10 milliseconds of other strobes per UL 1971 Standard.
  2. Indoor Wall Mounted Horn/Strobes, Genesis Series: Provide horn/strobes manufactured by EST. In - Out screw terminals shall be provided for wiring. The horn/strobes shall have a white face plate. They shall provide field configurable 15 cd, 30 cd, 75 cd or 110 cd synchronized flash outputs as required by the application. Horn shall be field selectable for low or high output.
  3. Indoor Ceiling Mounted Horn/Strobes, Genesis Series: Provide horn/strobes manufactured by EST. In - Out screw terminals shall be provided for wiring. The horn/strobes shall have a white face plate. They shall provide field configurable 15 cd, 30 cd, 75 cd or 95 cd synchronized flash outputs as required by the application. High output strobes shall provide field configurable 95 cd, 115 cd, 150 cd or 177 cd synchronized flash outputs as required by the application. Horn shall be field selectable for low or high output.
- D. Outdoor Horn/Strobes
1. Temporal Horn/Strobes, 757 Series
    - a. Provide electronic horn/strobes manufactured by EST, Cat. No. 757 Series. In - Out screw terminals shall be provided for wiring. The horn/strobe shall have a red plastic housing. Horn/strobes shall be selectable for high or low dBA output. Selection of low or high output shall be reversible. Horns shall be selectable for steady or temporal output. Selection of steady or temporal output shall be reversible.
    - b. The strobe shall provide 15/75 cd synchronized flash output as required by the application. The strobe shall have lens markings oriented for wall mounting.
    - c. Provide weatherproof wall boxes for outdoor mounting.
- E. Speakers:
1. Wall Mount: Provide speakers with a Mylar cone as manufactured by EST, Genesis Series. Paper type cones are not acceptable. The rear of the speaker shall be completely sealed protecting the cone during and after installation. In - Out screw terminals shall be provided for wiring. Speaker housings shall be white. Speakers shall be provided for use with 70V systems. Speakers shall provide power taps at 1/4w, 1/2w, 1w, and 2w selectable via switch mounted on unit. Speakers shall provide UL confirmed 90 dBA sound output at 2w.
  2. Ceiling Mount: Provide speakers with a 4 inch Mylar cone as manufactured by EST, Genesis Series. Paper type cones are not acceptable. The rear of the speaker shall be

completely sealed protecting the cone during and after installation. In - Out screw terminals shall be provided for wiring. Speaker shall be round, surface mount, slim profile with white finish. Speakers shall be provided for use with 70V systems. Speakers shall provide power taps at 1/4w, 1/2w, 1w, and 2w selectable via switch mounted on unit. Speakers shall provide UL confirmed 90 dBA sound output at 2w.

F. Speaker/Strobes:

1. Wall Mount: Provide speaker/strobes with as manufactured by EST, Genesis Series.
  - a. Provide speaker with Mylar cone. Paper type cones are not acceptable. The rear of the speaker shall be completely sealed protecting the cone during and after installation. In - Out screw terminals shall be provided for wiring. Speaker/strobe housings shall be white. Speakers shall be provided for use with 70V systems. Speakers shall provide power taps at 1/4w, 1/2w, 1w, and 2w selectable via switch mounted on unit. Speakers shall provide UL confirmed 90 dBA sound output at 2w.
  - b. Provide strobe with provide field configurable 15 cd, 30 cd, 75 cd or 95 cd synchronized flash outputs as required by the application. The strobe shall have lens markings oriented for wall mounting.
  - c. Provide high candela output strobe with provide field configurable 95 cd, 115 cd, 150 cd or 177 cd synchronized flash outputs as required by the application. The strobe shall have lens markings oriented for wall mounting.
2. Ceiling Mount: Provide speaker/strobes as manufactured by EST, Genesis Series.
  - a. Provide speaker with Mylar cone. Paper type cones are not acceptable. The rear of the speaker shall be completely sealed protecting the cone during and after installation. In - Out screw terminals shall be provided for wiring. Speaker shall be round, surface mount, slim profile with whit finish. Speakers shall be provided for use with 70V systems. Speakers shall provide power taps at 1/4w, 1/2w, 1w, and 2w selectable via switch mounted on unit. Speakers shall provide UL confirmed 90 dBA sound output at 2w.
  - b. Provide strobe with provide field configurable 15 cd, 30 cd, 75 cd or 95 cd synchronized flash outputs as required by the application. The strobe shall have lens markings oriented for ceiling mounting.
  - c. Provide high candela output strobe with provide field configurable 95 cd, 115 cd, 150 cd or 177 cd synchronized flash outputs as required by the application. The strobe shall have lens markings oriented for wall mounting.

G. Sprinkler Bell:

1. Provide electrically operated, 10 inch diameter, red color alarm gong with "Call Fire Dept." sign. Refer to mechanical drawings for locations. Coordinate exact mounting height and location with the Department. EST 439D-10AW on weatherproof back box.

H. Booster Power Supplies (BPS), EST BPS6A or BPS10A:

1. Provide, where needed GE Security, EST BPS6A booster power supplies as an extension of the Notification appliance circuits. The Booster Power Supplies, (BPS), units shall incorporate its own standby power supply capable of providing 24 hours of standby power followed by 5 minutes of alarm. The BPS shall be able to charge a 24 Amp Hour battery.
2. The BPS shall incorporate four independently supervised notification appliance circuits, (NAC). It shall be possible to configure the NACs so that they will follow the main FACP signal circuit's output or be activated and synchronized across the entire building via use of an EST SIGA-CC1S addressable module. The BPS shall be configurable to operate independently at any one of the following rates: continuous, 3-3-3 temporal, or code follower.
3. The BPS units shall have four configurable outputs that can be used for NAC control, or 24 volt DC power output for door holders, door locks or fan control power. Any of the circuits in the BPS shall be individually programmed to provide either 24 Volt DC NAC supervision and signal initiation or as a power riser for auxiliary control of Fire Alarm devices.

## 2.12 ANCILLARY DEVICES

- A. Remote Relays:
  - 1. Multi Voltage Control Relays, MR-100 Series: Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be SPDT and rated for 10 amperes at 115 VAC. A single relay may be energized from a voltage source of 24 VDC, 24 VAC, 115 VAC, or 230 VAC. A red LED shall indicate the relay is energized. A metal enclosure shall be provided.
  - 2. Multi Voltage Control Relays, MR-200 Series: Provide remote control relays connected to supervised ancillary circuits for control of fans, dampers, door releases, etc. Relay contact ratings shall be DPDT and rated for 10 amperes at 115 Vac. A single relay may be energized from a voltage source of 24 VDC, 24 VAC, 115 VAC, or 230 VAC. A red LED shall indicate the relay is energized. A metal enclosure shall be provided.

## 2.13 ELECTROMAGNETIC DOOR HOLDERS, 1500 SERIES

- A. Provide electromagnetic door holders with the following features.
  - 1. Flush mounted wall units or floor units as required by door and application.
  - 2. Silent operation.
  - 3. Minimum 25 Lbf. (111 Nt) holding force.
  - 4. 120V 60Hz operation.
  - 5. Finish shall be brushed zinc.
  - 6. EST 1500 Series.

## 2.14 SYSTEM MAP

- A. On wall beside Fire Alarm Control Panel, provide system map, framed under clear 1/8 inch plexiglass. Map shall consist of a basic floor plan of the entire building. Map shall be securely mounted on wall.
- B. Orient map in a manner that is consistent with the building. Rotate graphic layout and map as required showing North, South, East, and West as it applies to the specific building.
- C. Map shall show the location of every fire alarm initiating device in the building. Each device shall be assigned a unique sequential number, starting with "#01". This number shall be indicated on the map, along with the device type, and the number shall be marked on the device's base.
- D. LCD display on Fire Alarm Control Panel shall be programmed to give English-language description of each device by type, identifying number, and location. Example: "Sprinkler Zone 1 Flow Switch #01 (1983 Boiler Room)." Use actual room numbers, where available.

## 2.15 CONDUCTORS

- A. In general, conductors shall be of the sizes and types recommended by the system manufacturer.
- B. Voltage drop on Notification Appliance Circuits shall not exceed 10% at the most distant device on each circuit.

## 2.16 SPARE CAPACITY

- A. Signaling Line Circuits and Notification Appliance Circuits shall be sized to provide 20% spare capacity to allow future addition of devices.

## 2.17 SECONDARY SUPPLY CAPACITY AND SOURCES

- A. The secondary power supply for emergency voice/alarm communications service shall be capable of operating the system under maximum quiescent load for 24 hours and then shall be capable of operating the system during a fire or other emergency for a period of 2 hours. Fifteen minutes of evacuation alarm operation at maximum connected load shall be

considered the equivalent of 2 hours of emergency operation. For a combination system, the secondary supply capacity required above shall include the load of any non-fire related equipment, functions, or features which are not automatically disconnected upon transfer of operating power to the secondary supply.

- B. The secondary supply shall consist of the following:
  - 1. An automatic starting, engine driven generator arranged in accordance with NFPA 72 and storage batteries with 12 hours of capacity arranged in accordance with NFPA 72.
  - 2. Operation on secondary power shall not affect the performance of the fire alarm system.

## **2.18 CONCEALED NOTIFICATION DEVICES**

- A. Provide concealed notification devices at locations noted on the Drawings. The concealed fire notification appliance shall be Concealite Conceal-Alarm Series.
- B. The unit shall be wall or ceiling mounted and shall be controlled by the central fire system.
- C. Upon system activation, the door of the unit shall rotate 180 degrees and the fire notification appliance shall begin operation.
- D. Upon fire system shutdown, the door will rotate 180 degrees putting the appliance in the hidden or stored position.
- E. The standard unit shall be a white powder coat finish, and can be custom finished by factory, or in the field, using paint, wallpaper or appliqué.
- F. The unit shall fit in a standard stud wall, and back boxes shall be available for any standard wall or ceiling material.
- G. The unit shall interface seamlessly with any fire system and shall not affect or interfere with any diagnostic routines of the fire system.
- H. The unit shall be in conformance with NFPA 72 (National Fire Alarm Code).

## **PART 3 - EXECUTION**

### **3.1 FIELD QUALITY CONTROL**

- A. Document each installation and operational step utilizing the approved PC/FC checklists in accordance with Section 01 91 00 – Commissioning.

### **3.2 INSTALLATION (GENERAL)**

- A. The entire system shall be installed in a workmanlike manner in accordance with approved manufacturer's manuals and wiring diagrams. Furnish all conduit, wiring, Outlet Boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the NEC, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated conduit throughout.
- B. All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.
- C. Mount the Fire Alarm Control Panel enclosure(s) in the second floor Main Telecom Room.
- D. Field coordinates exact mounting locations.
  - 1. Where field conditions (such as conflicts with other features, obstructions that violate the placement rules of the applicable Fire Code, and the like) make necessary the relocation of detectors from the positions shown on the plans, such relocations shall be made in strict accordance with the applicable Fire Code, and shall be made at no additional cost to the Department.
  - 2. As far as possible within the rules of the applicable Fire Code, the final placement of exposed detectors shall present a uniform appearance.

- E. Wall mounted devices in finished areas such as manual fire alarm boxes and notification appliances shall be recessed in flush mounted junction boxes. Surface mounted box extensions shall not be used.
- F. Adjust each detector in accordance with manufacturer's recommendations for the specific location and circumstance.
- G. Detectors shall be installed a minimum of 3 feet from any supply or return air diffuser.
- H. Control functions which include outputs activated by specific inputs, such as door releases, elevator recall, fan shutdown, damper operation, etc., shall have both inputs and associated outputs connected to the same control panel. All control functions shall be accomplished with addressable control modules. Control through relay bases is not acceptable.
- I. Control relays shall be located within three feet of the device or circuit controlled in accordance with NFPA 72.
- J. Coordinate exact mounting locations with the reflected ceiling plans. Coordinate exact mounting heights with architectural elevations.
- K. Provide 3/4 inch C.O. with pull string between Fire Alarm Control Panel (FACP) and the Main Telecom Room (MTR) for future use. This conduit shall be in addition to any conduits required for this project.
- L. End of Line Resistors shall be furnished as required for mounting as directed by the manufacturer.

### 3.3 SYSTEM WIRING

- A. All wiring shall be in metal raceways shared by no other system. Raceways shall be installed in accordance with Section 26 05 34 - Conduit and Fittings. Fire alarm conduit shall be identified in accordance with Section 26 05 34 - Conduit and Fittings.
- B. Field devices shall be installed in accordance with Section 26 05 33 - Outlet Boxes. Paint boxes and covers red.
- C. Install Conductors in accordance with Section 26 05 10 - Wire and Cable. No wire nuts shall be used. All wires shall be landed on device terminals, or terminal strips or blocks, and shall be labeled and numbered at their terminations. All wiring shall be installed in a neat and workmanlike manner. Bundles of wiring shall be secured with self-locking nylon cable ties, not tape. If terminal strips or blocks are required to transition wire size down at devices, they shall not be located in the device junction box unless adequate space is available. Surface mounted box extensions shall not be used at recessed device locations to provide adequate room. If required, locate terminal strips or blocks in properly sized, separate junction boxes, located in accessible ceiling spaces. Clearly mark covers of junction boxes per Section 26 00 00 - Electrical General Requirements.

### 3.4 DUCT DETECTORS

- A. Smoke dampers and fire/smoke dampers: Coordinate installation of duct-mounted detectors for control of smoke dampers and smoke/fire dampers with Divisions 20, 21 and 22 and the Department. Locate duct mounted smoke detectors within five feet of smoke/fire dampers with no air inlets or outlets between detector and damper. Damper shall close when smoke detector goes into alarm.
- B. Air Handling Units: Coordinate installation of duct-mounted detectors with Divisions 20, 21 and 22 and the Department. Duct detectors shall be located in accordance with NFPA 72 and manufacturer's recommendation to the greatest extent practical. Proposed duct detector locations shall be submitted for approval prior to installation of any equipment. Submit duct detector differential pressure measurements to verify proper operation of duct detectors.

- C. Provide remote test stations for all duct mounted smoke detectors. Provide a descriptive label in accordance with Section 26 00 00 - Electrical General Requirements - IDENTIFICATION. Field coordinate location of remote test stations with the Department.

### **3.5 DETECTORS FOR DOOR RELEASE SERVICE**

- A. Ceiling-mounted detectors for door release service shall be centered on the opening, at a maximum distance of 5 feet-0 inches from opening. Minimum distance from opening shall be as noted in NFPA 72.
- B. Overhead Doors: Provide local release only for overhead doors. Power roll down door release mechanism from battery backed-up fire alarm auxiliary power source.

### **3.6 MAGNETIC DOOR HOLDERS**

- A. Unless otherwise noted or specified or dictated by the specified holder design, magnetic door holders shall be mounted near the top of the doors they serve, and within 6 inches of the latch-side edge of each door served.
- B. Door holders shall produce no objectionable hum. Repair, replace, or relocate all holders that produce audible hum.

### **3.7 PROTECTION OF FIRE ALARM CONTROL UNITS**

- A. Provide automatic smoke detection at the location of each fire alarm control unit(s) including fire alarm control panels, remote power supplies and remote booster power supplies.

### **3.8 DOOR UNLOCKING DEVICES**

- A. Any device or system intended to effect the locking/unlocking of emergency exits shall be connected to the building fire alarm system. These exits shall unlock upon receipt of any fire alarm signal.
- B. All emergency exits connected in accordance with [A.] above, shall unlock upon loss of the primary power to the fire alarm system. The secondary power supply shall not be utilized to maintain these doors in locked condition.

### **3.9 INTERCONNECTIONS TO OTHER SYSTEMS**

- A. Provide control module contacts in elevator machine rooms for connection to elevator controllers. Provide sufficient modules and contacts to obtain specified recall functions. Coordinate connections with Division 14.
- B. Provide input modules for monitoring of sprinkler flow, tamper, and low air pressure switches. Provide sufficient modules to give each switch an individual address. Connect supervised circuits from modules to switches and program system to provide specified functions for each switch.
- C. Monitor pre-action sprinkler control panels for sprinkler flow, tamper and low pressure conditions. Provide output from fire alarm system to pre-action panel to operate pre-action valve to charge sprinkler piping when a minimum of two smoke detectors in the covered area go into alarm.

### **3.10 PROGRAMMING**

- A. Provide system programming as required for operation of system as specified. Submit device locations and numbering scheme for approval prior to programming device descriptions.
- B. Reprogram system after substantial completion to make any Department-requested changes and to optimize system performance. Provide additional reprogramming during warranty period as required for proper system operation.

### 3.11 TESTING AND REPORTS

- A. Upon completion of the system installation, an Approved representative of the system manufacturer shall conduct a thorough test of the system and all related devices and components of the system, and submit a written report of the findings to the Department at least 72 hours prior to the substantial completion site observation. The testing shall include, at the least, verification of the following:
1. The functional operation of each resettable initiating device (manual fire alarm boxes, detectors, etc.) and circuit.
  2. The functional operation of each and every alarm device and circuit.
  3. The functional operation of each monitored device circuit.
  4. The functional operation of each control and output circuit.
  5. The supervision function of each Initiating, Indicating, Monitoring, Control and Supply Circuit.
  6. Central Station automatic signaling.
  7. Proper initiation and execution of mechanical systems control sequences.
  8. Verify that wire size, power supply, number of devices on a circuit, etc. are suitable to support 100% of devices being in alarm or operated simultaneously. Test shall include the following as a minimum:
    - a. Place all detectors and monitor modules in alarm. Each shall display its address and alarm condition. At least the first ten devices on each circuit shall also have their alarm LEDs lighted, where applicable.
    - b. Operate all control modules for the alarm or operated condition. Each module shall display its address and condition.
    - c. Reset all alarmed and operated devices. The panel shall display the address of any off-normal devices.
  9. Test a representative number of detectors for trouble by removing the detector from its base. The address and trouble condition for each shall be displayed. Insert a different type of detector into the base. The address and trouble condition shall be displayed. The detector shall return to normal only when the proper detector type is reinserted into the base.
  10. Print out the English-language descriptor, currently sensed value, pre-alarm threshold value, alarm threshold value and status of each sensor in the system. Also print out the English-language descriptor and status of each module in the system. The printout shall also include the date and time.

### 3.12 TRAINING

- A. After the system provided in this Section is completely installed and operational, and at a time chosen by the Department, provide the Department's system operators and maintenance personnel and representatives of the local Fire Department with a total of eight (8) hours of instruction on the operation, maintenance, and troubleshooting of all equipment provided under this Section.
- B. Training sessions shall be presented by a fully qualified, trained representative of the equipment manufacturer, who is thoroughly knowledgeable on the specific installation. Separate sessions shall be given for operation personnel (i.e.: facility staff and Fire Department) and maintenance personnel, with the length and content of the sessions tailored to the respective groups.
- C. Provide an additional two (2) hours of follow-up instruction for review and clarification at a later time mutually agreed on with the Department, if the Department deems it necessary.

### 3.13 ACCEPTABLE INSTALLERS

- A. The Fire Alarm / Life Safety System specified herein shall be installed by a Factory Trained and Authorized Engineered Systems Distributor.

- B. Field Connected Devices may be installed and wired, and licensed Contractors under the direct supervision of a Factory Trained and Authorized Engineered Systems Distributor may wire primary power. Installation shall be supervised and tested by trained representatives of the manufacturer of the system equipment who shall have a State fire alarm license.

### **3.14 EXAMINATION**

- A. Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm / Life Safety System and all associated components are to be installed shall be made.
- B. Any of these area(s) which are found to be outside the manufacturers' recommended environments for the particular specified products shall be noted on a Site Examination Report which shall be given to the Department.
- C. Any shorts, opens, or grounds found on existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

### **3.15 DEMONSTRATION**

- A. Each of the intended operations of the installed Fire Alarm / Life Safety System shall be demonstrated to the Department and the Local Authority Having Jurisdiction by the Installing Engineered System Distributor.

**END OF SECTION 28 31 13**

**SECTION 31 10 00  
CLEARING AND GRUBBING**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for clearing, grubbing, removing and disposing of all vegetation and debris (including earthen materials incidentally removed with vegetation and debris), and removing structures and obstructions located within the limits shown on the Drawings or designated by the DEPARTMENT, except such objects as are designated to remain in place or are to be removed in accordance with other sections of these Specifications. The WORK shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

**PART 2 – PROJECTS (Not Used)**

**PART 3 – EXECUTION**

**3.01 GENERAL**

- A. The DEPARTMENT will establish the limits of the WORK and will designate all trees, plants, shrubs and other items to remain. The CONTRACTOR shall protect and preserve all items designated to remain.
- B. Miscellaneous trimming of trees or shrubs designated to remain shall be conducted when directed by the DEPARTMENT. Trimming shall be in accordance with good tree surgery practice.
- C. All vegetation and debris to be removed shall be disposed of by the CONTRACTOR at approved disposal sites. No open burning shall be allowed on the Project site.
- D. The CONTRACTOR is responsible for:
  - 1. Securing waste disposal sites,
  - 2. Obtaining written permission of the owner of the disposal site and
  - 3. Securing any required permits, if none is indicated on the Drawings.

The cost of securing such sites shall be borne by the CONTRACTOR. If requested by the DEPARTMENT, the CONTRACTOR shall furnish the permit numbers of all required permits for disposal sites.

- E. Merchantable timber within the clearing limits will become the property of the CONTRACTOR, unless otherwise specified.

**3.02 GRUBBING**

- A. All trees, stumps, roots and other objects not designated to remain shall be cleared and grubbed. If the area is not to be benched, the removal of undisturbed stumps and roots and nonperishable solid objects that will be a minimum of four feet below the embankment surface and that do not extend more than six inches above the original ground line, will not be required.
- B. In areas outside of the grading limits of cut and embankment areas and to the established limits of the WORK, all stumps and nonperishable solid objects permitted to remain in place shall be cut off not more than six inches above the ground line or low water level.
- C. Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable materials and compacted in accordance with the Contract Documents.

**END OF SECTION**

**SECTION 31 20 00  
EROSION CONTROL**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary to maintain existing temporary erosion control devices; including, but not limited to, silt fences, settling ponds, wattles, rock check dams, ditches, etc. The WORK also includes preparing a SWPPP and HMCP.
- B. The WORK also includes sweeping, watering, vacuuming of the existing asphalt roadways and surfaces used, including the Foodland access, Whittier Street and Willoughby Avenue.

**1.03 DEFINITIONS**

- A. Erosion and Sediment Control Plan (ESCP). Permanent and temporary prevention of erosion and control of sedimentation during construction of the Project is included in the project Plans and Specifications.
- B. Storm Water Pollution Prevention Plan (SWPPP). The CONTRACTOR's site-specific plan for the permanent and temporary prevention of erosion and control of sedimentation during construction of the project. The SWPPP must address the requirements of the ESCP.
- C. Hazardous Material Control Plan (HMCP). The CONTRACTOR's detailed plan to prevent pollution from the use, containment, cleanup and disposal of hazardous materials (see 40 CFR 117 and 302 for listing), including petroleum products generated by construction equipment or activities.
- D. Final Stabilization. That point when all soil disturbing activities resulting from the project have been completed and a live uniform blanket of perennial vegetation, to preclude erosion, has been established on all unpaved areas (excluding graveled shoulders and crushed aggregate base course) not covered by permanent structures or equivalent permanent stabilization measures, such as use of riprap, gabions or geotextiles, have been implemented.
- E. Best Management Practices (BMP's). A wide range of project management practices, schedules of activities or prohibition of practices that when used singly or in combination, prevent or reduce erosion, sedimentation and pollution of adjacent water bodies and wetlands. BMP's include both structural devices and non-structural practices and can be temporary or permanent. The State of Alaska DOT/PF Best management Practices for Construction Erosion and Sediment Control describes a variety of standard BMP's.

**1.04 SUBMITTALS**

- A. Submit the following items for approval a minimum of 5 calendar days prior to the preconstruction conference.
  - 1. SWPPP
  - 2. HMCP

- B. The DEPARTMENT will review submittals within 14 calendar days then either approve them or require changes. If required for approval, modify the submittals within 5 calendar days of receiving comments from the DEPARTMENT.
- C. The approved SWPPP and HMCP become the project SWPPP and HMCP. Both must be signed by the CONTRACTOR and the DEPARTMENT. A copy must be kept on site by the CONTRACTOR.
- D. Once the SWPPP is approved, the DEPARTMENT will submit a copy of the State of Alaska Department of Environmental Conservation (DEC) Storm Water Coordinator.
- E. Follow the same approval process for amendments to the SWPPP as with the draft SWPPP.

## **PART 2 - PRODUCTS**

### **2.01 STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REQUIREMENTS**

- A. Use the ESCP as a basis to develop the SWPPP. Include revisions where necessary to accommodate your scheduling, equipment, or use of alternative BMP's. Base the SWPPP on the approach of first avoiding and preventing erosion, then minimizing erosion and finally trapping sediment before it leaves the project site.
- B. Address all ground disturbing activities required by the contract as well as those planned for your operations. Insure that all erosion, sediment and pollution control requirements are met for all activities associated with this contract and are addressed in the SWPPP.
- C. The plan must demonstrate that any offsite operations, including material sources, waste areas, and haul roads are in compliance with all local, state and federal erosion, sediment and pollution control requirements. When you obtain material from a commercial source, evidence of compliance is not required. A commercial source is defined as one that serves multiple unrelated projects and would continue to operate after project completion. A site developed solely for the project is considered a CONTRACTOR source.
- D. Have the SWPPP prepared under the direction of and sealed by a professional Engineer currently registered in the State of Alaska. Follow the format presented in the ESCP, and address all storm water discharge control and management issues identified by and discussed in the ESCP:

#### **1. Site Description**

- a. Description of the nature of the construction activity.
- b. Description of the intended sequence of major activities which disturb soils on major portions of the site (within the right-of-way limits and including grubbing, excavation, grading and other work in or near surface waters).
- c. Estimates of the total area of the project site (including related off-site areas) and the total area that is expected to be disturbed by excavation, grading, or other activities.
- d. Estimate of appropriate drainage parameters for the site before, during, and after construction activities are completed; narrative and/or data describing existing conditions of the soil, including soil loss parameters for disturbed soils, and the quality of any discharge from the site, including pass-through discharges.
- e. Site map indicating drainage patterns and approximate slopes anticipated after major grading activities, areas of soil disturbance, an outline of the areas which will not be disturbed, the location of major structural and nonstructural erosion, sediment and pollution controls identified in the Plans, the location of areas

where stabilization practices are expected to occur, location of all surface waters (including wetlands and all waters that will pass through the project site), and locations where storm water is discharged to a surface water.

- f. Identify all receiving waters and wetlands within or adjacent to the site which will be disturbed or which will receive discharges from disturbed areas of the project.

2. Control Measures. Describe the appropriate control measures to be implemented at the construction site and off-site areas. Clearly describe for each major activity, appropriate control measures and the period during the construction process that the measures will be implemented. Address erosion and sediment controls, stabilization practices, structural practices, and permanent storm water management as described in the ESCP.

Specifically address your plan for controlling and managing erosion and sedimentation during construction at the following locations.

- a. Cut and fill slopes steeper than 2:1 and over 16 feet in height.
  - b. All construction adjacent to existing drainages, streams, lakes, water bodies, wetlands, and other sensitive areas.
  - c. Culvert installations and/or bridge construction.
  - d. Department designated disposal sites and material sites.
  - e. Any additional sites which may be sensitive due to the proposed construction operation (including contractor supplied material and disposal sites, staging areas, stockpile locations, and slopes opened up after the seeding deadline).
3. Maintenance. Include a description of maintenance procedures for the timely inspection and maintenance of vegetative cover, temporary and permanent erosion and sediment control measures, and other protective measures identified in the SWPPP and the contract Plans and Specifications. Specifically address details to stabilize the site prior to winter shutdown.
  4. Inspections. Identify the CONTRACTOR personnel responsible for inspection of the project's erosion and pollution control measures.
  5. Non-storm Water Discharges. Identify on-site sources of non-storm water associated with the construction activity, including those combined with storm water discharges from the site. Exclude flows from fire fighting activities. Identify appropriate pollution prevention measures for the non-storm water component(s) of the discharge.
  6. Responsible Party. Clearly identify for each measure shown in the plan, the CONTRACTOR and/or subcontractors that will implement and maintain the measure.

## 2.02 HAZARDOUS MATERIAL CONTROL PLAN (HMCP) REQUIREMENTS

- A. Prepare a HMCP which details your plan for fueling and maintaining equipment and machinery and the storage of fuels and petroleum products. Identify the locations where fueling and maintenance activities will take place, and all controls to contain the accidental spillage of petroleum products.
- B. List and give the location of potentially hazardous materials, including petroleum products, to be used and/or stored on site, and their estimated quantities. List the types and quantities of equipment and materials available on site to be used for hazardous material containment and cleanup.
- C. Detail your plan for storing hazardous materials as well as disposing of waste petroleum products and/or other hazardous materials generated by the project.

- D. Detail your plan for the prevention, containment, cleanup and disposal of soil and water contaminated by accidental spills. Detail your plan for dealing with unexpected contaminated soil and water encountered during construction. Specify the line of authority and designate a field representative for spill response for the CONTRACTOR and each subcontractor.

### **PART 3 - EXECUTION**

#### **3.01 CONSTRUCTION REQUIREMENTS**

- A. Do not begin earth disturbing work until written approval of the SWPPP and HMCP has been received from the DEPARTMENT.
- B. Contain, clean up, and dispose of all construction related (including office facilities) discharges of petroleum products and/or other materials hazardous to the land, air, water and organic life forms. Perform all fueling operations in a safe and environmentally responsible manner. Comply with the requirements of 18 AAC 75 and AS 46, Oil and Hazardous Substances Pollution Control.
- C. Implement all temporary and permanent erosion and sediment control measures identified in the SWPPP and ensure that the SWPPP remains current.
- D. Prior to the start of construction, conduct a joint on-site inspection with the DEPARTMENT, and the professional Engineer who sealed the SWPPP, to discuss the implementation of the requirements of the SWPPP. Conduct additional joint inspection, as needed, when requested by the DEPARTMENT or the CONTRACTOR.
- E. Willoughby Avenue, Whittier Street and Foodland access shall be kept free of mud, silt, rocks, gravel, etc. from the CONTRACTOR's hauling operation. These roads shall be kept clean by use of power sweepers, capable of picking up debris from the road and washing on a routine basis during hauling operations, or more frequently, as directed by the DEPARTMENT.
- F. The CONTRACTOR is responsible to prepare, submit and maintain a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the Alaska Construction General Permit (CGP) to the EPA and ADEC that is in accordance with their construction methodologies and sequence. This includes submission of a Notice of Intent (NOI) to the EPA. The CONTRACTOR shall provide a copy of the NOI to the DEPARTMENT at the time of submission of the NOI.
- G. The CONTRACTOR shall submit to the DEPARTMENT an Erosion and Sediment Control Plan, a copy of the NOI and documentation of their submittal of the NOI to ADEC prior to beginning any WORK at the Project site. WORK at the Project site will not be permitted until approval of this Plan has been obtained from the governing agency or agencies.
- H. The CONTRACTOR shall submit NOT (Notice of Termination) at completion of the WORK and removal of all SWPPP items.
- I. Prior to winter shutdown, ensure that the site has been stabilized as detailed in the SWPPP. Prior to project closeout and demobilization, the DEPARTMENT will review all areas disturbed by construction to determine if final stabilization is complete.

- J. The Contractor shall maintain existing temporary erosion control structures as necessary and/or as directed by the DEPARTMENT for the duration of the contract. They shall be maintained in effective operating conditions at all times. Rock check dams, straw hay bale check dams and silt fences shall be cleaned whenever they have become half-filled with silt or debris, and other items shall be cleaned, repaired, or replaced as necessary.
- K. Temporary erosion control structures shall remain in place until the DEPARTMENT approves their removal.

**END OF SECTION**

**SECTION 31 20 01  
EXCAVATION AND EMBANKMENT**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for excavation and embankment construction to the lines, grades and cross sections indicated in the Drawings or as directed by the DEPARTMENT.

**1.03 SUBMITTALS**

- A. Select Borrow – sample for gradation analysis.
- B. Shot Rock Borrow – samples for gradation and/or visual analysis.

**PART 2 – PRODUCTS**

**2.01 EXCAVATION**

- A. All excavation shall be unclassified excavation, and shall consist of excavation and disposal of all materials, of whatever character, encountered in the WORK.

**2.02 EMBANKMENT**

- A. Material for embankment construction shall consist of non-frost-susceptible earth, sand, gravel, fractured rock or combination thereof containing no muck, peat, frozen materials, roots, sod or other deleterious materials, and shall be compactable to the density required by the Specifications.

**2.03 SELECTED EMBANKMENT**

- A. Selected Embankment shall meet all the requirements for Embankment Material, and in addition, shall have a plasticity index not greater than 6 as determined by AASHTO T 90 and shall contain no more than 6% by weight of material passing the 200 mesh sieve. The percentage of material passing the 200 mesh sieve shall be determined using only the material which passes a 3 inch sieve.

**2.04 BORROW**

- A. Borrow shall meet the requirements for Embankment above.

**2.05 SELECTED BORROW**

- A. Selected Borrow shall meet the requirements for Selected Embankment above.

**2.06 SHOT ROCK BORROW**

- A. Shot Rock Borrow shall conform to the following gradation:

<b>SIEVE DESIGNATION</b>	<b>PERCENT PASSING BY WEIGHT</b>
12 Inch	100
8 Inch	85 - 100
4 Inch	10 - 50
No. 200*	0 - 3

*\*Gradation shall be determined on that portion passing the 3-inch screen*

- B. At least 50% by weight of the particles retained on the 3/8-inch sieve shall have at least two fractured faces as determined by ATM T-4.
- C. Elongation Specification  
The length of the crushed stone backfill shall not be more than twice the designated screed diameters.
- D. Sodium Sulfate Loss  
Aggregate shall pass the percent sodium sulfate loss per AASHTO T 104 with 9% maximum.
- E. Shot Rock Borrow for this Project shall have a maximum Nordic Abrasion value of 22. Test procedure for Nordic Abrasion is Alaska Test Method 312. This is available at the State of Alaska Department of Transportation and Public Facilities Southeast Region Materials Laboratory.
- F. Shot Rock Borrow shall consist of 12-Inch minus shot rock and shall contain no muck, frozen material, rocks, sod or deleterious matter. Shot rock borrow material shall be obtained from a local rock quarry. Shot Rock Borrow material shall not consist of predominantly all one size, or an open graded mix, but rather a uniform grading of shot rock material smaller than 12-inch in size. Shot Rock Borrow shall be free of schist that cleaves along preferred foliation planes. Shot Rock Borrow shall be free of platy mineral grains. Metamorphic shot rock shall be free of slaty cleavage.

**2.07 2-INCH MINUS SHOT ROCK**

- A. 2-Inch Minus Shot Rock shall contain no mulch, frozen material, roots, sod or other deleterious matter.
- B. The shot rock shall have a plasticity index not greater than 6, as determined by AASHTO T 90. It shall consist of not more than 3% by weight of particles that pass the NO. 200 sieve, as determined by ATM T-7.
- C. At least 50% by weight of the particles retained on the 3/8-inch sieve shall have at least two fractured faces as determined by ATM T-4.
- D. At least 70% by weight of particles shall be retained on the 1-inch sieve.
- E. Elongation Specifications:

The length of the crushed stone backfill shall not be more than twice the designated screen dimensions.

- F. Sodium Sulfate Loss:  
Aggregate shall pass the percent sodium sulfate loss per AASHTO T 104 with 9% maximum.
- G. LA Abrasion:  
Percent of wear per AASHTO T 96 shall be 45% maximum.
- H. 2-Inch Shot Rock for this Project shall have a maximum Nordic Abrasion value of 22. Test procedure for Nordic Abrasion is Alaska Test Method 312. This is available at the State of Alaska Department of Transportation and State of Alaska Department of Transportation and Public Facilities Southeast Region Materials Laboratory.

### **PART 3 – EXECUTION**

#### **3.01 EXCAVATION**

- A. Excavations shall be reasonably smooth and uniform to the lines, grades and cross sections shown in the Drawings or as directed by the DEPARTMENT. Excavations shall be conducted to ensure that material outside of excavation limits remains undisturbed.
- B. Excavations shall be protected from erosion and maintained to drain freely at all times.
- C. When excavation to the limits indicated on the Drawings encounters unsuitable underlying material, the DEPARTMENT may require the CONTRACTOR to remove the unsuitable material and backfill with approved material. The CONTRACTOR shall take the necessary cross section measurements before backfill is placed in order to measure the amount of unsuitable material removed.
- D. Excavated soils that do not meet the requirements for embankment material and surplus suitable excavation shall be disposed of by the CONTRACTOR at a location and in a manner approved by the DEPARTMENT. No material may be wasted without the prior approval of the DEPARTMENT.
- E. The CONTRACTOR is responsible for securing a waste disposal site if none is indicated on the Drawings. The CONTRACTOR shall obtain the written permission of the landowner for use of all disposal sites, and shall either obtain any required permits or assure that they have been obtained by others. If required by the DEPARTMENT, the CONTRACTOR shall furnish the permit numbers of all required permits for the disposal sites. The costs of securing such sites shall be borne by the CONTRACTOR.
- F. Temporary storage of useable or suitable excavation is the responsibility of the CONTRACTOR, and no additional payment will be made.
- G. The CONTRACTOR shall conduct all operations to prevent contaminating useable excavation with unsuitable material.
- H. The CONTRACTOR shall provide added care when excavating adjacent to existing roadways, sidewalks, curbs and underground utilities. Damage caused to existing roadways, sidewalks, curbs and underground utilities by the CONTRACTOR shall be repaired at the CONTRACTOR's expense.

- I. After excavation to the subcut limit is complete and prior to backfilling with Shot Rock Borrow, the bottom of the subcut shall be proof rolled with an excavator or backhoe-mounted vibrating compactor until a firm base for the backfill material is obtained.

### **3.02 EMBANKMENT**

- A. Embankments shall be constructed to a reasonably smooth and uniform shape conforming to the lines, grades and cross sections indicated on the Drawings or as directed by the DEPARTMENT.
- B. Embankment construction includes, but is not limited to, placing and compacting selected borrow adjacent to building foundation walls and footings, access ramps, sidewalks, curbs and underground structures. Only approved materials shall be used in the construction of embankments and backfills. Embankment material will be approved for gradation following placement, but prior to compaction.
- C. Embankment shall not be placed on frozen ground.
- D. Red top grading hubs shall be set to top of select borrow for this project in all areas where additional select borrow has been placed and compacted to ensure proper elevations have been obtained. They shall be set by the CONTRACTOR at breaks in the grade and on even grade intervals not to exceed 50 feet, with additional stakes at vertical curves.
- E. When embankment is to be placed on both sides of a concrete wall or box-type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.
- F. The finish subgrade surface (bottom of base course level) shall not vary more than 0.05-foot when tested using a ten foot straightedge, applied parallel with and at right angles to the centerline of the roadway or parking area to receive base course grading D-1 material, nor vary more than 0.05-foot from the established grade.
- G. If continued hauling over a completed or partially completed embankment causes loss of stability as evidenced by pumping or rutting, or other damage, the CONTRACTOR shall repair the damaged embankment at its own expense and adjust its hauling equipment and procedures so as to avoid further damage.

### **3.03 EMBANKMENTS CONSTRUCTED WITH MOISTURE DENSITY CONTROL**

- A. Except for embankments constructed predominantly of rock fragments or boulders, all embankments shall be constructed with moisture density control. Embankments shall be placed in horizontal layers not to exceed 12 inches in depth, loose measurement, for the full width of the embankment, except as required for traffic, and shall be compacted before the next layer is placed. A smaller depth will be required if the compaction equipment is considered by the DEPARTMENT to be insufficient to obtain the required densities. Embankments shall be compacted at the approximate optimum moisture content to not less than 95% of the maximum density as determined by AASHTO T 180 D or Alaska T-12. Embankment materials may require drying or moistening to bring the moisture content near to optimum. In-place field densities will be determined by Alaska T-3 or T-11. Sufficient time shall be allowed between placement of layers to allow for field density tests.

### **3.04 EMBANKMENTS CONSTRUCTED FROM ROCK FRAGMENTS**

- A. When embankment material consists predominantly of rock fragments or boulders too large to be contained in the lift thickness specified without crushing or further fracturing, such material may be placed in lifts not exceeding in thickness the approximate average size of the larger rocks, or 18 inches, whichever is less.
- B. This material shall not be dumped in final position but shall be deposited on the fill and distributed by blading or dozing so that voids, packets and bridging will be reduced to a minimum. Intervening spaces and interstices shall be filled with smaller stones and earth to form a dense, well compacted embankment. Hauling equipment shall be uniformly routed over the entire width of the embankment, and compaction equipment shall be utilized if necessary to assure that a well-compacted embankment is obtained.
- C. Compaction shall be obtained by routing construction equipment and/or rollers uniformly over the entire surface of each layer before the next layer is placed.
- D. Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until compaction has been completed and approved by the DEPARTMENT's on-site representative.
- E. All shot rock borrow surfaces shall be rolled full width with a minimum of eight passes of a vibratory grid roller (minimum centrifugal force shall be 50,000 lb) prior to placement of subsequent layer of material. A vibratory grid roller will be required for this project.

### **3.05 DITCH GRADING**

- A. Ditch Grading shall include all excavation, backfill, compaction, grading and other WORK necessary to construct drainage ditches, cobble lined drainage ditch, sidewalk side slopes, roadway side slopes and parking lot side slopes outside the subcut limits shown or described on the Drawings, in these Specifications, or as directed by the DEPARTMENT.
- B. All ditches or swales shall be graded to a smooth, uniform grade, free of humps or low areas that cause standing water in excess of 1-inch deep.
- C. Ditch Grading includes grading to the limits necessary to provide a smooth, uniform transition from the ditch swale to the existing undisturbed areas. All slopes shall be 3:1 or flatter, unless shown on the Drawings or other wise approved by the DEPARTMENT.

### **3.06 SELECT BORROW**

- A. Select Borrow material shall be placed and compacted over the existing select borrow surface as necessary to meet the embankment tolerances specified in Part 3.2, Embankment. All pot holes, wash boarding and contaminated select borrow material shall be regarded to meet these tolerances. Select Borrow shall be compacted to 95% of the maximum dry density unit weight as determined by AASHTO T-180D test method.

**3.07 INDIVIDUAL MINING PLAN**

- A. If the CONTRACTOR decides to use material from the City/State Lemon Creek Borrow Pit, or CBJ Stabler's Point rock quarry, the CONTRACTOR shall provide an Individual Mining Plan that conforms to the requirements of Section 007000 – General Conditions.
- B. If Individual Mining Plan shall be developed using the survey information provided by the DEPARTMENT, or the CONTRACTOR may provide an independent survey with two-foot contours of the City/State Lemon Creek Borrow Pit, or CBJ Stabler's Point rock quarry. The survey shall provide sufficient survey information to calculate quantities, shown drainage features and property boundaries. If the CONTRACTOR uses the DEPARTMENT furnished survey information, the Individual Mining Plan shall be done in a Windows-based AutoCAD format, utilizing the current AutoCAD release in use by the DEPARTMENT.

**3.08 2-INCH MINUS SHOT ROCK w/BASE COURSE**

- A. The full depth of 2-inch minus shot rock shall be graded to a uniform surface and compacted with a vibratory roller prior to placing base course, Grading D-1. No base course, Grading D-1, shall be placed until the 2-inch minus shot rock layer has been approved by the DEPARTMENT.
- B. If base course, Grading D-1, is used as a leveling course for the curb and gutter, all of this base course material shall be removed from the 2-inch minus shot rock to the front face of the concrete gutter, and the additional 2-inch minus shot rock required to bring the street area to its required full depth shall be placed, graded and compacted prior to placing the top layer of base course, Grading D-1.

**END OF SECTION**

**SECTION 31 20 02  
TRENCHING**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for the excavation and backfill required for installation of pipelines, manholes, vaults, diversion structures, and other appurtenances; and for ground surface restoration, including pavement.

**PART 2 - MATERIALS**

**2.01 TRENCH EXCAVATION**

- A. Trench excavation shall consist of all material, of whatever nature, excepting liquids, excavated from trenches.

**2.02 BEDDING**

- A. Bedding, Class A, shall be aggregate conforming to the following gradation:

<b>Sieve Designation</b>	<b>Percent Passing by Weight</b>
1-1/2"	100
No. 4	0-35
No. 200	0-8

- B. Bedding, Class B, shall be three inch minus material, free of muck, frozen material, lumps, organic material, trash, lumber or other debris, with no more than eight percent passing the No. 200 screen.

**2.03 BACKFILL**

- A. Backfill is defined as material placed above the level of bedding material. Backfill material consists of native material excavated from the trench that is determined by the DEPARTMENT to be suitable as backfill. Backfill material used under asphalt or concrete pavement, as shown on the Drawings, shall be non-frost-susceptible, granular material that is free of rocks larger than six inches, much, frozen material, lumps, organic material, trash, lumber, or other debris. All backfill material available from trench excavation shall be utilized prior to the use of the imported backfill.

## 2.04 IMPORTED BACKFILL

- A. Imported backfill shall be granular material, free draining, free of much, frozen material, lumps, or organic material and shall conform to the following gradation:

Sieve Designation	Percent Passing by Weight
3 Inch	100
No. 4 *	20-70
No. 200 *	0-6

\*Gradation shall be determined on that portion passing the three inch screen.

## 2.05 AGGREGATE BASE

- A. Aggregate base shall conform to Grading D-1 of Section 321003 - Base Course.

## 2.06 ASPHALT CONCRETE PAVEMENT

- A. Asphalt concrete pavement shall conform to that specified in Section 321216 - Asphalt Concrete Pavement. Aggregate gradation and asphalt cement percentages shall conform to Type II-A, Class B for roadways and parking lots. Current safety and pollution controls shall be met.

## 2.07 PORTLAND CEMENT CONCRETE

- A. Portland cement concrete shall conform to that specified in Section 321313 - Site Concrete.

## PART 3 - EXECUTION

### 3.01 EXCAVATION

- A. Excavation for trenches shall conform to the lines and grades shown on the Drawings and to the limits depicted in the Drawings. The CONTRACTOR shall also do any WORK necessary to prevent surface water from entering the trench.
- B. Excavation of any and all material more than six inches below the invert of the pipe as shown on the Drawings shall be done only when ordered in writing by the DEPARTMENT. The material so excavated will be handled in the manner described below:
1. All excavated material suitable for use as backfill shall be piled in an orderly manner separately from unsuitable material, at a sufficient distance from the edge of the trench to prevent material from sloughing or sliding back into the trench. When the trench is in a traveled roadway the DEPARTMENT may require removal and temporary storage of excavated material elsewhere.
  2. Materials unsuitable for use as backfill shall be hauled to a CONTRACTOR furnished disposal site off of the Project, unless otherwise directed in writing by the DEPARTMENT. The CONTRACTOR is responsible for securing waste disposal sites if none is indicated on the Drawings. The CONTRACTOR shall obtain the written permission of the landowner for use of all disposal sites, and shall either obtain any required permits or assure that they have been obtained by others. If requested by the DEPARTMENT, the CONTRACTOR shall furnish

- the permit numbers of all required permits for the disposal sites. The cost of securing such sites shall be borne by the CONTRACTOR.
3. If the CONTRACTOR fails to comply with the provisions of any state statute, city ordinance or permit pertaining to waste disposal or disposal sites, the DEPARTMENT shall have the right, after giving 30 days written notice, to bring the disposal sites into compliance and collect the cost of the WORK from the CONTRACTOR, either directly or by withholding monies otherwise due under the Contract.
- C. No more than 150 feet of trench shall be open in advance of laying the pipe, and no more than ten feet of trench shall remain open at the end of each working period. When the trench is in a traveled roadway, it shall be completely backfilled, in accordance with the Specifications, and the roadway opened to traffic at the end of each working period.
  - D. The CONTRACTOR shall protect and preserve all existing pavement, throughout the entire construction period. No tracked equipment may be operated on any pavement without first protecting the pavement with pavement pads approved by the DEPARTMENT. All pavement which is damaged in any manner by the CONTRACTOR's operations shall be restored to original or better condition at the CONTRACTOR's expense. Repair WORK to state highways shall be in all ways satisfactory to the Alaska Department of Transportation and Public Facilities.
  - E. Where required to prevent caving of the trench, or by any safety law or regulation such as OSHA, the CONTRACTOR shall furnish and install bracing and/or sheeting to protect the excavation. This bracing and/or sheeting shall be removed as trench backfill progresses.
  - F. Excavations for manholes and similar structures shall be large enough to provide proper working room. Any over depth excavation shall be backfilled with concrete or other approved material at the CONTRACTOR's expense.
  - G. The CONTRACTOR shall provide temporary support of existing structures, as necessary, to protect the structures from settlement or other disturbances caused by construction activities. All structures disturbed by the CONTRACTOR's activities shall be returned to original condition, or better.

### **3.02 BEDDING**

- A. Bedding shall be placed in conformance with the lines and grades shown on the Drawings. Before placing any bedding material, the bottom of the trench shall be hand raked ahead of the pipe laying operation to remove stones and lumps which will interfere with smooth and complete bedding of the pipe. The specified bedding material shall then be placed in layers the full width of the trench, each layer not exceeding eight inches in thickness loose measure, and compacted to 95% of maximum density as determined by AASHTO T 180 D, until the elevation of the plan grade for the pipe invert is attained. The pipe bed shall then be fine-graded by hand and compacted as above. Bell holes shall be hand dug at the location of joints and shall be of sufficient size to allow proper making of the joint and to prevent the collar or bell of the pipe from bearing on the bottom of the trench.
- B. After the pipe has been laid and approved for covering, the specified bedding material shall be placed evenly on both sides of the pipe for the full width of the trench. Approval for covering does not imply final acceptance of the pipe, or relieve the CONTRACTOR in any way of responsibility to complete the Project in conformance with the Drawings and Specifications. Bedding material shall be placed in layers. The thickness, loose measure, or the first layer shall be either one-half the outside diameter of the pipe plus two inches

or eight inches, whichever is least. This layer shall be compacted as specified above to provide solid support to the underside of the pipe.

- C. The bedding material shall be placed and compacted in layers not more than eight inches in thickness, loose measure, up to a plane 12 inches above the top of the pipe.
- D. The initial density test at any location will be paid for by the DEPARTMENT. If the initial test shows that the material compaction is not as specified, the CONTRACTOR shall modify the compaction methods used, as approved by the DEPARTMENT, and have the material re-tested until the tests show that the compaction method meets with the Specification requirements. If the CONTRACTOR's compaction methods are not consistent and/or do not meet the requirements of these Specifications, the DEPARTMENT reserves the right to undertake additional compaction tests as necessary to determine the extent of substandard compaction, and to charge the CONTRACTOR for all such tests.

### **3.03 BACKFILL**

- A. The trench shall be backfilled above the bedding material, as shown in the Drawings, with approved material saved from trench excavation. If there is not sufficient approved material from the excavation, the backfilling of the trench shall be completed utilizing imported backfill. The backfill and/or imported backfill shall be compacted to 95% of optimum density within the street and sidewalk limits, as shown on the Drawings, and 90% elsewhere, as determined by AASHTO T 180 D. Lifts shall not exceed 12 inches in depth for loose material. After backfilling of the trench is completed, any excess material from trench excavation shall be hauled to a CONTRACTOR furnished disposal site off of the Project.
- B. Where trenches cross roadways, streets or driveways, etc., backfilling shall be done immediately following excavation and laying of the pipe. All crossings shall be backfilled, compacted, and open to traffic at the end of each working period. Major road crossings shall be excavated and backfilled in half widths of the traveled way so that at least one-half of the roadway is open to controlled traffic at all times during the WORK. All WORK performed within a right-of-way shall be done in conformance with the appropriate permits issued by the respective agency having jurisdiction over the right-of-way.
- C. At least 24 hours prior to commencing backfilling operations, the CONTRACTOR shall notify the DEPARTMENT of the proposed method of compaction. No method will be approved until the CONTRACTOR has demonstrated, under actual field conditions, that such method will produce the degree of compaction required.
- D. The initial density test at any location will be paid for by the DEPARTMENT. If the initial test shows that the material compaction is not as specified, the CONTRACTOR shall modify the compaction methods used, as approved by the DEPARTMENT, and have the material re-tested until the tests show that the compaction meets the Specification requirements. If the CONTRACTOR's compaction methods are not consistent and/or do not meet the requirements of these Specifications, the DEPARTMENT reserves the right to undertake additional compaction tests as necessary to determine the extent of substandard compaction, and to charge the CONTRACTOR for all such tests.

### **3.04 AGGREGATE BASE**

- A. Aggregate base shall be placed in layers not exceeding six inches compacted depth, extending the full width of the trench and compacted to 95% of maximum density as determined by AASHTO T 180 D. The thickness of the top layer shall be such that, after

compaction, the surface shall be at the elevation shown in the Drawings. Care shall be taken to ensure proper compaction near the sides of the trench, and to avoid segregation.

### **3.05 ASPHALT CONCRETE PAVEMENT**

- A. Pavement to be removed shall be neatly saw cut full depth along straight lines. Only such pavement shall be removed as is necessary to excavate for the appurtenances, but the pavement shall be cut a sufficient distance outside the excavation to prevent damage to adjacent pavement by lifting or tearing the mat. All removed pavement shall be disposed of at the asphalt disposal stockpile in the CBJ/State Lemon Creek Gravel Pit.
- B. After trench backfilling is complete, the edges of existing pavement shall be neatly saw cut vertically as shown in the Drawings. All loose, cracked or undermined sections of existing pavement shall be removed. A tack coat shall be placed on the existing pavement edge just prior to placing new pavement.
- C. Pavement shall be replaced in accordance with Section 321216 - Asphalt Concrete Pavement, and as shown on the Drawings. Pavement shall be placed in all streets and parking lots, as soon as possible, after completion of backfilling. All trenched highway crossings shall be patched within five days from the date each trench is first opened, unless otherwise shown in the Contract Documents, or approved by the DEPARTMENT. When weather conditions, unavailability of material, or time preclude placing permanent pavement within five days, temporary pavement shall be installed. Temporary paving will consist of at least a two inch thick layer of a pre-mixed, asphaltic surfacing material, and shall be installed and maintained flush with the existing surface until the permanent pavement is in place. Temporary pavement shall be removed prior to placing permanent pavement.
- D. There shall be zero grade change perpendicular to the trench.
- E. Permanently seal any cracks at joints with hot bitumenum after the permanent asphalt is in place. The CONTRACTOR shall repair all failed seals at joints during the 12 months after the date of final payment.

### **3.06 PORTLAND CEMENT CONCRETE**

- A. Portland cement concrete shall be replaced in accordance with Section 321313 - Site Concrete, and the details shown on the Drawings.

**END OF SECTION**

**SECTION 31 20 03  
BASE COURSE**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and placing one or more layers of aggregate base or leveling course on a prepared surface to the lines and grades shown on the Drawings.

**1.03 SUBMITTALS**

- A. Base course grading D-1 gradation and modified proctor from independent laboratory from current construction season.

**PART 2 - PRODUCTS**

**2.01 MATERIAL**

- A. Aggregate base course shall consist of crushed gravel or crushed stone, conforming to the quality requirements of AASHTO M 147. The aggregate shall be free from lumps, balls of clay, or other objectionable matter, and shall be durable and sound.
- B. The base course shall be sampled according to "WAQTC FOP for AASHTO T2-Sampling Aggregates" as described in the *Alaska Test Methods Manual*, published by the Alaska Department of Transportation and Public Facilities.
- C. Coarse aggregate (that material retained on a No. 4 sieve) shall be crushed stone and shall consist of sound, tough, durable rock of uniform quality. Rock shall be free of schist that cleaves along preferred foliation planes. Rock shall be free of platy mineral grains. Metamorphosed rock shall be free of slaty cleavage. All material shall be free of from clay balls, vegetable matter or deleterious matters. Coarse aggregate shall not be coated with dirt or other finely divided matter. All aggregates shall be free of roots and wood. In addition, coarse aggregate shall meet the following requirements:

L.A. Wear, %, 25% maximum loss in accordance with AASHTO T 96.

Degradation Value, 45 minimum in accordance with ATM 313.

Sodium Sulfate Soundness Loss, %, 9 maximum in accordance with AASHTO T 104.

- D. Base course material shall conform to the following gradations:

**BASE COURSE GRADING D-1 GRADATION**

(Percent passing by weight)

<b>Sieve Size</b>	<b>D-1</b>
1"	100
3/4"	70-100
3/8"	50-80
No. 4	35-50
No. 8	20-35
No. 40	8-20
No. 200	0-6

For grading D-1, at least 70% by weight of the particles retained on a No. 4 sieve shall have at least one fractured face as determined by Alaska T-4.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Prior to placement of the base course, the underlying surface shall be prepared by dressing, shaping, wetting or drying, and compacting of the underlying material to a minimum density of 95% as determined by AASHTO T 180-D. Surfaces shall be cleaned of all foreign substances and debris.
- B. Any ruts or soft yielding spots that may appear shall be corrected by loosening and removing unsatisfactory material and adding approved material as required, reshaping, and recompacting the affected areas to the lines and grades indicated on the Drawings. If required by the DEPARTMENT the CONTRACTOR shall proof load questionable areas with a loaded truck or other piece of equipment approved by the DEPARTMENT.
- C. Blue-top grading hubs shall be set to the top of base course at centerline and at the edge of asphalt pavement where no curb and gutter is to be installed. They shall be set by the CONTRACTOR at breaks in grade and on even grade at intervals not to exceed 25 feet, with additional stakes at vertical and horizontal curves.
- D. Base course material shall be deposited and spread in a uniform layer to the required grades, and to such loose depth that when compacted to the density required, the thickness will be as indicated on the Drawings. Portions of the layer which become segregated shall be removed and replaced with a satisfactory mixture, or shall be remixed to the required gradation.
- E. The maximum compacted thickness of any one layer shall not exceed six inches, except the compacted depth of a single layer may be increased to eight inches if compaction equipment capable of delivering sufficient compactive energy, as determined by the DEPARTMENT, is used. If the contract documents require the compacted depth to exceed six inches, the base shall be constructed in two or more layers of approximately equal thickness. Each layer shall be shaped and compacted before the succeeding layer is placed.
- F. The base course shall be compacted to at least 95% of maximum density as determined by AASHTO T 180-D. In places not accessible to rolling equipment, the mixture shall be compacted with hand-tamping equipment.

- G. Blading, rolling, and tamping shall continue until the surface is smooth and free from waves and irregularities. If at any time the mixture is excessively moistened, it shall be serrated by means of blade graders, harrows, or other approved equipment, until the moisture content is such that the surface can be recompacted and finished as above.
- H. The grading operations shall be conducted in a manner that will remove any quarter crowns, or other humps in the cross section of the roadway. The cutting edges of the grading blade shall be replaced if they are found to be worn beyond the tolerances specified for the roadway surface. The finished surface shall not have humps or dips between blue-topped intervals along the roadway alignment that exceed the tolerances given in the following paragraph, I.
- I. The finished surface of the base course, when testing using a ten foot straightedge shall not show any deviation in excess of 3/8 inch between two contact points. The finish surface shall not vary more than 1/2 inch from established grade. Additionally, the algebraic average of all deviations from established grade of the finish base course surface elevations taken at 50-foot intervals shall be less than 0.02 foot.
- J. The initial density at any location will be paid for by the DEPARTMENT. If the initial test shows that the material compaction is not as specified, the CONTRACTOR shall modify the compaction methods used, as approved by the DEPARTMENT, and have the material retested until the tests show that the compaction meets the Specification requirements. All tests, after the initial test at any given location, shall be paid for by the CONTRACTOR.

**END OF SECTION**

**SECTION 31 20 04  
FILTER MATERIAL**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK of this Section includes providing all labor, materials, tools and equipment necessary to complete construction of the filter material for the retaining wall drains, building foundation drains and roof drains as shown on the Drawings.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Filter material shall be gravel consisting of crushed or naturally occurring granular material. It shall be washed and free of clay particles and conforming to the following gradation.

<b>SIEVE SIZE</b>	<b>PERCENT PASSING BY WEIGHT</b>
2"	100
1-1/2"	95-100
3/4"	0-20
3/8"	0-5

- B. Foundry sand and other material which may be cementitious or not suitable for water percolation shall not be used.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. The filter material shall be placed to the lines, grades, and thickness shown on the Drawings and shall be placed on all sides of perforated pipes to form a wall drain.

**3.02 PREPARATION OF THE SUBBASE**

- A. Subbase preparation shall consist of dressing, shaping, wetting, and compacting of the subbase to a minimum density of 95%.

- B. Surfaces shall be cleaned of all foreign substances and debris. Any ruts or soft yielding spots that may appear in the subbase surface shall be corrected by loosening, removing and adding approved material, reshaping and re-compacting the affected areas to the line, grade, and to the specified density requirements.

**3.03 PLACING**

- A. Filter material shall be deposited and spread in a uniform layer to the required contour and grades.

- B. The filter material shall be completely encapsulated in geotextile, Type A filter cloth. See Section 323000.
- C. Compacting the filter material is generally not required, however, the material shall be lightly tamped to ensure uniformity.
- D. Care shall be taken to maintain the proper grade on the wall drainpipe while placing the filter material.

**END OF SECTION**

**SECTION 31 23 16  
REMOVE AND DISPOSE OF CULVERT PIPE**

**PART 1- GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, tools and equipment necessary for removal and disposal of all existing culverts and headwalls within the Project limits designated for removal.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. All culvert pipe shown on the Drawings for removal shall be removed and backfilled with suitable material to match the adjacent ground surface. This WORK will include, but not limited to removal and disposal of existing culverts and headwalls. Usable material from Project trench excavation shall be used as backfill. Pipe to be disposed shall be removed from the Project and disposed in a legal manner.

**END OF SECTION**

**SECTION 31 23 17  
STORM AND SANITARY STRUCTURE REMOVAL**

**PART 1- GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools, and equipment necessary for removal and disposal of existing storm manholes and catch basins and sanitary manhole structures.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Storm and sanitary sewer structures designated on the Drawings to be removed, shall be removed and backfilled with suitable material to the excavation subcut limits. Structures to be disposed shall be removed from the Project and disposed in a legal manner.

**END OF SECTION**

**SECTION 31 23 18  
TEMPORARY ENVIRONMENTAL CONTROLS**

**PART 1 - GENERAL**

**1.01 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.

**1.02 DUST ABATEMENT**

- A. The CONTRACTOR shall furnish all labor, equipment, and means required and shall carry out effective measures wherever and as often as necessary to prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity. The CONTRACTOR shall be responsible for any damage resulting from any dust originating from its operations. The dust abatement measures shall be continued until dust is no longer produced and the CONTRACTOR is relieved of further responsibility by the DEPARTMENT.

**1.03 RUBBISH CONTROL**

- A. During the progress of the WORK, the CONTRACTOR shall keep the site of the WORK and other areas used by it in a neat and clean condition, and free from any accumulation of rubbish. The CONTRACTOR shall dispose of all rubbish and waste materials of any nature occurring at the WORK site, and shall establish regular intervals of collection and disposal of such materials and waste. No burning is permitted on site. The CONTRACTOR shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of all rubbish and surplus materials shall be off the site of construction in accordance with local codes and ordinances governing locations and methods of disposal, and in conformance with all applicable safety laws, and to the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

**1.04 SANITATION**

- A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.
- B. Sanitary and Other Organic Wastes: The CONTRACTOR shall establish a regular daily collection of sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of away from the site in a manner satisfactory to the DEPARTMENT and in accordance with all laws and regulations pertaining thereto.

**1.05 CHEMICALS**

- A. All chemicals used during Project construction or furnished for Project operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in paragraph 6.11 of the General Conditions.

**1.06 EAGLE NESTING TREES**

- A. Eagle nesting trees are known to exist in the Juneau area, although none are known to exist in the immediate vicinity of the Project site. The CONTRACTOR has the responsibility for adherence to the Bald Eagle Protection Act (16 U.S.C. 668-668d) which prohibits molesting or disturbing bald eagles, their nests, eggs, or young.
- B. Guidelines for compliance to the Bald Eagle Protection Act are supervised by the U.S. Department of the Interior, Fish and Wildlife Service, Raptor Management Studies, 3000 Vintage Blvd, Suite 201, Juneau, Alaska 99801, phone (907) 586-7333 or (907) 586-7243. The contact person is Mike Jacobson, Eagle Management Specialist. The CONTRACTOR shall contact the Eagle Management Specialist for guidelines of the Bald Eagle Protection Act.

**PART 2 - PRODUCTS** (Not Used)

**PART 3- EXECUTION** (Not Used)

**END OF SECTION**

**SECTION 31 23 19  
DEWATERING**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. This Section includes provisions for site dewatering during excavation operations for the Project. Dewatering consists of lowering and controlling groundwater levels and hydrostatic pressures to permit site and building excavation, shot rock borrow placement and compaction. All equipment, materials and labor necessary shall be furnished by the CONTRACTOR to ensure dewatered conditions.

**1.03 QUALITY ASSURANCE**

- A. Maintain adequate supervision and control to ensure that stability of excavated and constructed slopes are not adversely affected by water, erosion is controlled, and flooding of excavation does not occur.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.01 DEWATERING**

- A. Provide an adequate system to lower and control groundwater in order to permit excavation and placement of shot rock borrow materials. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of storm drains, sewers, water main and other excavations.
- B. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of WORK under construction or completed. Dispose of water in a manner to avoid inconvenience to others. Provide sumps, sedimentation tanks, and other flow control devices as required by governing authorities to maintain proper water quality.
- C. The CONTRACTOR shall submit a dewatering plan to the DEPARTMENT. Written approval shall be obtained prior to commencement of WORK.
- D. The dewatering plan shall include, but should not be limited to the following provisions:
  - 1. Prevent surface or groundwater from flowing into or accumulating in excavations.
  - 2. Prevent water from flowing in an uncontrolled fashion across the project site or to erode slopes or to undermine cut slopes.
  - 3. Prevent water from being diverted onto adjacent properties.
  - 4. Provide continual and effective drainage of excavations.
  - 5. Provide and maintain temporary diversion ditches, dikes, and grading as necessary. Trench excavations shall not be used for this purpose.
  - 6. Provide sumps, wellpoints, French drains, pumps, and other control measures necessary to keep excavations free of water.

7. Provide control measures prior to excavation to water level and maintain water level continuously below working level.

**END OF SECTION**

**SECTION 31 60 00  
CONSTRUCTION SURVEYING**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary to perform all surveying and staking necessary for the completion of the Project in conformance with the Drawings and Specifications and DEPARTMENT surveying practices, including all calculations required to accomplish the WORK.
- B. The WORK shall include the staking, referencing and all other actions as may be required to preserve and restore land monuments and property corners which are situated within the Project area, and to establish monuments as shown on the Drawings.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION**

**3.01 CONSTRUCTION**

- A. All surveying involving property lines or monuments shall be done by, or under the direction of, a Registered Land Surveyor licensed in the State of Alaska.
- B. The DEPARTMENT will supply information relative to the approximate locations of monuments and corners, but final responsibility for locations, referencing, and restoration shall rest with the CONTRACTOR.
- C. In the event the CONTRACTOR does not replace the survey monuments and property corners disturbed by the CONTRACTOR's operations, the DEPARTMENT may, after first notifying the CONTRACTOR, replace the monuments in question. The cost of such replacements shall be deducted from payments to the CONTRACTOR.
- D. The CONTRACTOR shall provide the DEPARTMENT with a copy of all surveyors' notes, if requested by the DEPARTMENT, prior to each Pay Request payment.
- E. The CONTRACTOR shall provide the DEPARTMENT with a copy of all surveyors' notes, prior to the request for final payment, and include the information on the record drawings.
- F. The CONTRACTOR shall obtain all information necessary for as-built plan production, from actual measurements and observations made by its own personnel, including Subcontractors, and submit this information to the DEPARTMENT.
- G. The CONTRACTOR shall use competent, qualified personnel and suitable equipment for the layout work required and shall furnish all stakes, templates, straightedges and other devices necessary for establishing, checking and maintaining the required points, lines and grades.

- H. The CONTRACTOR shall perform all staking necessary to delineate clearing and/or grubbing limits; all cross sections necessary for determination of excavation and embankment quantities, including intermediate and/or remeasure cross sections as may be required; all slope staking; all staking of culverts and drainage structures, including the necessary checking to establish the proper location and grade to best fit the conditions on site; the setting of such finishing stakes as may be required; the staking of right-of-way; the staking, referencing and other actions as may be required to preserve or restore land monuments and property corners; and all other staking necessary to complete the project.
- I. Field notes shall be kept in standard bound notebooks in a clear, orderly and neat manner, consistent with DEPARTMENT surveying practices. The CONTRACTOR's field books shall be available for inspection by the DEPARTMENT at any time.
- J. All field survey notes, including those which become source documentations from which quantities for payment are computed, shall be recorded by a notekeeper furnished by the CONTRACTOR. The notekeeper shall be thoroughly familiar with generally accepted standards of good survey notekeeping practice.
- K. The DEPARTMENT may randomly spot-check the CONTRACTOR's surveys, staking and computations at the DEPARTMENT's discretion. After the survey or staking has been completed, the CONTRACTOR shall provide the DEPARTMENT with a minimum of 72 hours notice prior to performing any WORK, and shall furnish the appropriate data as required, to allow for such random spot-checking; however, the DEPARTMENT assumes no responsibility for the accuracy of the WORK.

**END OF SECTION**

**SECTION 32 12 16  
ASPHALT CONCRETE PAVEMENT**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. WORK consists of the furnishing and mixing of aggregate, asphalt cement, and additives at a mixing plant and the hauling, spreading, and compaction of the asphalt concrete mixture on a previously prepared surface, all as specified in the contract and in conformance with the lines, grades and thicknesses shown on the Drawing.
- B. Asphaltic concrete mix for the parking lots, access roadway and sidewalks shall be Type II-A, Class B.

TABLE 321216-1

<b>ASPHALTIC CONCRETE MIX REQUIREMENTS</b>		
DESIGN PARAMETERS	CLASS A	CLASS B
Stability, lbs.	1,800	1,800
Flow, 0.01 inch (0.25 mm)	8-14	8-14
Voids in total mix, percent	3-5	2.5 – 4.0
Compactions, number of blows each side of test specimen	75	50
Dust-asphalt ratio (1)	0.6-1.0	0.6-1.0
Percent oil content	5.3-6.2	6.0% min.
Voids in the mineral aggregate (VMA) Minimum value		
Type I	13.0	12.0
Type II or IIA	14.0	13.0
Type III	15.0	14.0

(1) Dust-asphalt ratio is defined as the percent of material passing the U.S. No. 200 sieve divided by the percent of asphalt (calculated by weight of mix).

**PART 2 - PRODUCTS**

**2.01 COMPOSITION OF ASPHALT CONCRETE MIXTURES - JOB MIX DESIGN**

- A. Asphalt concrete mixtures shall be composed of aggregate, asphalt cement, and required additives combined within the limits for the type and class specified in the contracts.
- B. It is the CONTRACTOR's responsibility to ensure that, in addition to the aggregate gradation requirements, the aggregate material meets all the requirements of this Section and asphalt concrete mixture meets the applicable design parameters, when tested according to ATM T-17.
- C. At least 15 days prior to the production of asphalt concrete pavement the CONTRACTOR shall submit a current mix design. The mix design shall be performed within six (6) months of the construction season. The following related items shall be submitted with the mix design:

1. Notification that aggregate proposed for the asphalt concrete mixture is available for sampling.
  2. A letter stating the proposed gradation for the Trial Job Mix Design, gradations for individual stockpiles, and blend ratio for each aggregate stockpile.
  3. A minimum of three (3) one-gallon samples of the asphalt cement proposed for use in the mixture, including name of product, manufacturer, test results as required, manufacturer's certificate of compliance, and a temperature viscosity curve for the asphalt cement.
  4. A 1/2 pint sample of the anti-strip additive proposed, including name of product, manufacturer, and manufacturer's data sheet, and current Materials Safety Data Sheet (MSDS).
  5. The CONTRACTOR shall accompany the DEPARTMENT during sampling, and shall furnish all the assistance needed to ensure that the DEPARTMENT obtains representative samples.
  6. The mix design shall be 50 blow Marshall Method.
- D. The DEPARTMENT will evaluate the gradation for the Trial Job Mix Design and suitability of the materials submitted. If the asphalt concrete mixture conforms to the design parameters specified in Table 321216-1 when tested according to ATM T-17, the DEPARTMENT will approve the Trial Job Mix Design and specify a target value for the asphalt cement content, mixing temperature and additives.
- E. If the Trial Job Mix Design does not conform to the design parameters specified in Table 321216-1, when tested by the DEPARTMENT, the CONTRACTOR shall submit in writing to the DEPARTMENT another proposed gradation for a second Trial Job Mix Design. Samples of aggregate and additional asphalt cement shall be obtained in the same manner as for the original Trial Job Mix Design. The DEPARTMENT shall evaluate and test the second Trial Job Mix Design and either approve or disapprove the design based on the contract requirements. The above procedure shall be repeated until the Trial Job Mix Design is approved.
- F. If the CONTRACTOR proposes a change in source of aggregate material, source of asphalt cement, or a change in the gradation target values after production has started, the CONTRACTOR shall submit in writing the proposed gradation target values to the DEPARTMENT and request a new Trial Job Mix Design be evaluated for approval. The CONTRACTOR shall accompany the DEPARTMENT during sampling and shall furnish all assistance needed to assure that the DEPARTMENT obtains representative samples. Approval of the new Trial Job Mix Design and/or aggregate material will require testing and evaluation. Trial Job Mix Design test results will be available within 15 calendar days of submittal. If the asphalt concrete mixture conforms to the design parameters specified in Table 321216-1 when tested in accordance with ATM T-17, the DEPARTMENT will develop a new target value for the asphalt cement content, mixing temperature and additives. The new target values for gradation and asphalt cement content will only be in effect on asphalt concrete mixture produced after the CONTRACTOR submittal of the new gradation target values for the Trial Job Mix Design.
- G. The location and type of the mixing plant shall be included with the Trial Job Mix Design data. Asphalt concrete mixtures produced from different plants shall not be mixed.
- H. All trial job mix designs as required will be assessed and paid for by the CONTRACTOR.

## **2.02 ASPHALT AGGREGATES**

- A. Aggregate for Plant Mix Asphalt Pavement:

1. Coarse Aggregate: Coarse aggregate (that material retained on the No. 4 sieve) shall be crushed stone and shall consist of sound, tough, durable rock of uniform quality. Rock shall be free of schist that cleaves along preferred foliation planes. Rock shall be free of platy mineral grains. Metamorphosed rock shall be free of slaty cleavage. All material shall be free from clay balls, vegetable matter or other deleterious matters. Coarse aggregate shall not be coated with dirt or other finely divided mineral matter. All asphalt aggregates shall be free of roots and wood. In addition, coarse aggregate shall meet the following requirements:

Nordic Abrasion Value	Nordic Abrasion Test Procedures <sup>1</sup>	16.0 Max.
Percent of Wear	AASHTO T 96	25 max.
Degradation Value	ATM T-13	30 min.
Percent Sodium Sulfate Loss	AASHTO T 104	10 max.
Percent Fracture	ATM T-4	100 min. single face/ 80 min. double face

2. Asphalt concrete aggregate shall not exceed eight percent thin - elongated pieces as determined by ATM T-9.
3. Fine Aggregate: Fine aggregate (passing the No. 4 sieve) shall meet the quality requirements of AASHTO M 29. Fine aggregate angularity shall be 40 minimum as determined by AASHTO T 304.
4. The several aggregate fractions for the mixture shall be sized, graded, and combined in such proportions that the resulting composite blend conforms to the grading requirements of Table 321216-2. Aggregates gradations shall be determined by ATM T-7, except when the sample is obtained by extraction.
5. Asphalt aggregate may be a blend but shall be 80% mechanically crushed with no more than 20% natural sand.
6. The material furnished shall conform to the approved Job Mix Design within the tolerances specified, except the limits given in Table 321216-2 may not be exceeded.

<u>Sieve Size</u>	<u>Tolerance % Passing</u>
¾ inch	100
½ inch	± 6
3/8 inch	± 6
No. 4	± 6
No. 8	± 6
No. 16	± 5
No. 30	± 4
No. 50	± 4
No. 100	± 3
No. 200	± 1

<sup>1</sup> Nordic Abrasion Test Procedures will apply to both the coarse and intermediate aggregate for asphalt aggregate. Test procedures for Nordic Abrasion are available at AKDOT&PF SE Region Materials Laboratory.

TABLE 321216-2

ASPHALT CONCRETE AGGREGATE Percent Passing by Weight				
Sieve Design	Type I	Type II	Type II-A	Type III
1-inch	100			
3/4 inch	80-95	100	100	
1/2 inch	60-88	80-95	86-98	100
3/8 inch	48-77	60-87	74-86	80-95
No. 4	28-63	36-48	46-58	44-81
No. 8	14-55	19-35	29-41	26-70
No. 16	9-46	10-25	18-28	16-59
No. 30	6-39	7-21	11-19	9-49
No. 50	5-29	5-20	6-14	6-36
No. 100	4-18	4-15	3-9	4-22
No. 200	2-6	2-6	2-6	2-6

**2.03 ASPHALT MATERIALS**

- A. "The grade of asphalt cement material will be PG 58-22. The asphalt cement material shall conform to the applicable requirements of this Section and will be conditionally accepted at the source. If the material is to be conditionally accepted at the source, the CONTRACTOR shall provide a manufacture's certificate of compliance in accordance with this section and test results of the applicable quality requirements of this Section before the material is shipped. If there is a change in the source of the asphalt cement or if the kinematic viscosity (viscosity at 275°F) of the asphalt supplied for the Trial Job Mix Design by a factor of two (doubles or halves) or more, then operations shall be suspended while a new Trial Job Mix Design proposal is submitted for approval.
- B. ASPHALT CEMENT
- Asphalt cement shall be designated PG58-22 and conform to the requirements listed on the chart on the next page.
- C. CUT-BACK ASPHALTS
- Cut-back asphalts shall conform to the requirements of AASHTO M 81 and M 82 except as follows:

- a. In Table 1 of M 82, reduce the minimum absolute viscosity on residue from distillation at 60°C to 100, in the MC-30 and MC-250 columns, and revise the maximum distillate percentage by volume of total distillate at 225°C for MC-30 to read: 35%.

TEST FOR	SPECIFICATIONS	AASHTO TEST METHOD	SPECIFICATIONS
Penetration	(4°C [39.2°F], 200g, 60s), dmm RTFO Aged Residue <u>Note 1</u>	T 49	15+
Ductility	(7.2°C [45°F], 1 cm/min), cm RTFO Aged Residue	T 51	10+
Absolute Viscosity	(60°C [140°F]), P Original Binders RTFO Aged Residue	T 202 T 202	1,100+ 1,500-6,000
Kinematic Viscosity	(60°C [140°F]), RTFO Viscosity/Orig. Viscosity	T 201	275+
Absolute Viscosity Ratio	(60°C [140°F]), RTFO Viscosity/Orig. Viscosity		4.0-
Flash Point, Cleveland Open Cup	C(F) Original Binder	T 48	232°+(450°+)
Solubility in Trichloroethylene	%, Original Binder	T 44	99.0+
Ductility	(25°C [77°F], 5 cm/min), cm RTFO Aged Residue	T 51	75+

Note 1 "RTFO Aged Residue" means the asphaltic residue obtained using the rolling thin film oven test (RTFO Test), AASHTO T 240.

D. EMULSIFIED ASPHALTS

1. CCS-1 cationic emulsified asphalts shall comply with the requirements listed in Table 321216-3.
2. CCS-1 Cationic Emulsified Asphalt shall conform to the requirements of AASHTO M 208.

TABLE 321216-3

TESTS ON EMULSION	
Viscosity @ 77°F., SSF	30 max.
Storage Stability, 1 day, %	1 Max.
Demulsibility 35 ml. 0.8% SDS, %	25 min.
Particle Charge	Positive*
Sieve, % retained	0.10 max.
Distillation Oil by Vol. of Emulsion, %	5 max.
Distillation Residue by Wt. of Emulsion, %	45 min.
TESTS ON RESIDUE	
Penetration @ 77°F.	100-200
Ductility @ 77°F., 5 cm/min., cm	40 min.
Solubility in TCE, %	97.5 min.

\* If particle charge test is inconclusive, material having a max. Ph value of 6.7 will be acceptable.

E. STORAGE AND APPLICATION TEMPERATURES

1. Asphalt materials required by the Specifications shall be stored and applied within the temperatures ranges indicated below:

TABLE 321216-4  
STORAGE AND APPLICATION TEMPERATURES

Type and Grade of Material	Spray °F	Mix °F	Storage °F
MC-30	85+		140 Max
MC-250	165+	165-220	240 Max
RC-800	200+		200 Max
CRS-2	125-175		100-175
CMS-2	125-175	120-160*	100-175
CSS-1	90-120	90-160*	50-125
AC-2.5	270+	235-280**	325 Max
AC-5	280+	250-295**	325 Max
AC-10	280+	250-315**	325 Max
STE-1	70-140	70-150	50-125
PG58-22		350 max	275-325°F

\* Temperature of the emulsified asphalt in the pugmill mixture.

\*\* As required to achieve Kinematic viscosity of 150-300 centistokes.

**2.04 ANTI-STRIP ADDITIVES**

- A. Anti-strip agents shall be used in the proportions determined by ATM T-14 and shall be included in the approved Trial Job Mix Design. At least 70% of the aggregate shall remain coated when tested in accordance with ATM T-14.

**2.05 PROCESS QUALITY CONTROL**

- A. The DEPARTMENT has the exclusive right and responsibility for determining the acceptability of all materials incorporated into the Project. It is expressly understood, however, that the CONTRACTOR is solely responsible for the sampling and testing of material for process control of the asphalt concrete mixture including screening, crushing, blending, stockpiling of the aggregate and production of the asphalt concrete mixture and monitoring compaction of the asphalt concrete mixture.
- B. The results of the acceptance testing performed by the DEPARTMENT may not be available to the CONTRACTOR until a period of at least seven working days has elapsed from the date of sampling.

**PART 3 - EXECUTION**

**3.01 WEATHER LIMITATIONS**

- A. The asphalt concrete mixture shall not be placed on a surface with standing water, on an unstable roadbed when the base material is frozen, or when weather conditions prevent the proper handling or finishing of the mixture. No asphalt concrete, Type II, or Type III mixture, shall be placed unless the surface temperature is 40°F or warmer.

### 3.02 EQUIPMENT

- A. All equipment shall be in good working order and free of asphalt concrete mix buildup. All equipment shall be available for inspection and demonstration 72 hours prior to placement of asphalt concrete.
- B. Bituminous Mixing Plants:
  - 1. Mixing plants shall conform to AASHTO M 156.
  - 2. Proportioning (batch) scales shall not be used for weighing material for payment. Weigh scales used in conjunction with a storage silo may be used to weigh the final product for payment, provided the scales are certified.
- C. Hauling Equipment:
  - 1. Trucks used for hauling asphalt mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of either paraffin oil, lime water solution as approved by the DEPARTMENT. Diesel or fuel oil shall not be used.
  - 2. Each truck shall have a watertight canvas cover of such size as to extend at least one foot over the sides and end of the truck bed and be adequately secured to protect the asphalt concrete mixture. The use of the canvas cover shall be at the DEPARTMENT's direction.
- D. Asphalt Pavers:
  - 1. Asphalt pavers shall be self-propelled units, provided with a heated vibratory screed. Grade and cross slope shall be controlled through the use of automatic grade and slope control devices. The paver screed control system shall be automatically actuated by the use of a string line, or minimum 30-foot long ski. The length of the string line shall be adjusted to produce the required surface smoothness.
  - 2. The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.
  - 3. The screed assembly shall produce a finished surface of the required smoothness, thickness, and texture without tearing, shoving, or displacing the asphalt concrete mixture. Screed extensions used for paving a constant width shall be heated and vibrated. Auger extensions shall be the same length as the rigid screed extensions.
  - 4. The use of a pickup machine to transfer the asphalt mixture from a windrow to the paver hopper will be permitted, provided the pickup machine is capable of collection of the windrowed material without damage to the underlying course. The DEPARTMENT will not allow the continued use of the pickup machine if segregation, excessive temperature loss, or any detrimental effects are observed.
  - 5. Paver hopper wings shall either be left in the top or down position throughout the paving operation. If the CONTRACTOR wishes to dump the wings during paving, the material on the wings and in the hopper shall not be incorporated into the finish mat or included in the quantity for payment.
  - 6. The screed assembly shall have a joint compaction device and a joint edge restrainer.

E. Rollers

1. The CONTRACTOR shall supply a sufficient number and weight of rollers to compact the mixture to the required density while maintaining the pace of the paving operations. Rollers shall be of the static steel wheel, vibratory steel wheel, and pneumatic tire type, self propelled and capable of reversing without backlash. They shall be specifically designated to compact hot asphalt concrete mixtures. The use of equipment which results in crushing of the aggregate will not be permitted. Pneumatic tire rollers shall be fully skirted; shall be at least six (6) feet wide; and shall be configured so that the rear group of tires align to cover the spaces between the front group of tires. The roller shall have an operating weight per tire of at least 3,000 pounds. Tires shall be of equal size, a minimum of 20 inches in diameter, shall be inflated to at least 80 psi and maintained so that tire pressures do not vary more than 5 psi between any two (2) tires

- F. Sidewalks shall be paved with a pull box-type paver, as manufactured by Layton Manufacturing Co., or similar equipment. Heavy, self-propelled laydown units that will place concentrated loading on curb and gutter sufficient to cause breakage, or other damage to the concrete, will not be permitted.

**3.03 PREPARATION OF EXISTING SURFACE**

- A. The existing surface shall be prepared in conformance with the Drawings and Specifications. Existing paved surfaces shall be cleaned of loose material by sweeping with a power broom, supplemented by hand sweeping, if necessary.
- B. Contact surfaces of curbing, gutters, manholes, and other structures shall be coated with a thin, uniform coating of tack coat material in conformance with Section 321217 - Tack Coat prior to the asphalt mixture being placed.
- C. Surfaces which have received a prime coat shall be allowed to cure such that the prime coat is not picked up by the haul vehicles. Surfaces which have received an emulsion tack coat shall be allowed to break prior to placement of asphalt concrete mixture.
- D. The grading, shaping, and strengthening where applicable, of the road surface shall be as specified in Section 312003 - Base Course.
- E. A string line installed by the CONTRACTOR at the direction of the DEPARTMENT will be the edges of paving.
- F. Prior to paving over any existing pavement, the surface shall be thoroughly cleaned and an application of tack coat applied that will provide a strong bond between the two layers.

**3.04 PREPARATION OF ASPHALT**

- A. A continuous supply of the asphalt cement shall be supplied to the mixer at a uniform temperature, within 25°F of the Job Mix Design mixing temperature.

**3.05 PREPARATION OF AGGREGATES**

- A. The aggregate for the asphalt concrete mixture shall be heated and dried to a temperature compatible with the mix requirements specified. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid the presence of unburned fuel on the aggregate. Any asphalt concrete mixture in which soot or fuel is present shall be wasted and no payment made.

- B. Drying operations shall reduce the aggregate moisture content to the extent that the moisture content of the asphalt concrete mixture, sampled at the point of acceptance for asphalt cement content, shall be no more than 0.5% (by total weight of mix), as determined by ATM T-25.

### **3.06 MIXING**

- A. The aggregate, asphalt cement additives shall be combined in the mixer in the amounts required by the Job Mix Design.
- B. The materials shall be mixed such that a complete and uniform coating of the aggregate is obtained. For batch plants, dry aggregate shall be placed in motion immediately prior to the addition of asphalt cement. Wet mixing time shall be adequate to obtain 98% coated particles when tested in accordance with AASHTO T 195.
- C. The temperature of the asphalt concrete mixture at the time of the mixing shall be as determined by the Job Mix Design.

### **3.07 TEMPORARY STORAGE OF ASPHALT CONCRETE MIXTURE**

- A. Temporary storing or holding of hot asphalt concrete mixture in silo type storage bins will be permitted.
- B. All the asphalt concrete mixture drawn from the silo type storage bins shall conform to all of the requirements for asphalt concrete mixtures as if loaded directly into hauling equipment from the mixing plant. Signs of visible segregation, heat loss, changes from the Job Mix Design, change in the characteristics of asphalt cement, lumpiness or stiffness of the mixture will be cause for rejection.
- C. Unsuitable asphalt concrete mixture shall be disposed of by the CONTRACTOR at no cost to the DEPARTMENT.

### **3.08 SPREADING AND PLACING**

- A. The CONTRACTOR shall submit a Paving Plan for the DEPARTMENT's review a minimum of five (5) working days prior to initiating the paving operation. The Paving Plan shall consist of, but not be limited to, the following:
  - 1. Paving schedule to include sequence of operations.
  - 2. Paving schedule distributed to residents within the Project boundary.
  - 3. Operational details to include:
    - a. Plant operating capacity and target production rate.
    - b. Number and capacity of trucks, cycle time, and delivery rate.
    - c. The manufacturer and model of the paver and pickup machine, to include information on grade followers, sensors, operating speed and production rate of the pavers.
    - d. Number, type, weight, and operating speed of rollers.
    - e. Location of longitudinal joints.
    - f. Method of constructing transverse joints.
    - g. Construction plan for paving intersections and driveways.
    - h. The manufacturers, model number, and the last certified calibration date for the CONTRACTOR's nuclear densometer gauge.

- B. The asphalt concrete mixture shall be laid upon a surface approved by the DEPARTMENT, spread and struck off to the required compacted thickness. Asphalt pavers shall be used to distribute the asphalt concrete mixture in lanes of such widths as to hold to a practical minimum the number of longitudinal joints required, subject to the requirements of this Section.
- C. When laying asphalt concrete mixtures, the paver shall be operated at uniform forward speeds consistent with the delivery of asphalt concrete mix to avoid unnecessary stopping and starting of the paver.
- D. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the asphalt concrete mixture shall be spread, raked and luted by hand tools. For such areas the asphalt concrete mixture shall be placed to the required compacted thickness.
- E. Any asphalt concrete mixture which is observed to be contaminated or segregated will be rejected.
- F. When the section of roadway being paved is open to traffic, adjacent traffic lanes shall be paved to the same elevation within 24 hours unless prevented by weather or other factors beyond the CONTRACTOR's control.
- G. When multiple lifts are specified in the contract, the final lift shall not be placed until all other lower lift pavement throughout that section, as defined by the Paving Plan, has been placed and accepted. Paving shall not begin until all adjacent curb has been poured and cured for 72 hours or until satisfactory strength is achieved.
- H. Manholes, cleanouts and water valve boxes shall be raised to grade prior to paving the final lift. The structures shall have no less than 3/8" and no greater than 3/4" depression from adjacent asphalt to top of the lid. Manholes not meeting tolerances will be repaired as per Concrete Transition Slab detail shown in the Drawings.
- I. Unless waived by the DEPARTMENT the asphalt pavement in the parking lots shall be paved in a single day's operation so no cold joints will result.

### **3.09 COMPACTION**

- A. Immediately after the asphalt mixture has been spread, struck-off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.
- B. Minimum compaction shall be 94% of AASHTO T 209. The target value for density will be 94 to 97% of the maximum specific gravity (MSG) as determined in accordance with AASHTO T 209 for the first sample from each lot of asphalt concrete mixture, as defined in this Section. Acceptance testing for field density will be determined in accordance with ATM T-18 or ASTM D-2950, as directed in writing by the DEPARTMENT.
- C. The asphalt concrete mixture, including the leveling course, shall have a minimum of three (3) complete passes with a pneumatic-tired roller prior to cooling to 175°F. A pass is defined as once over each point on the pavement surface.
- D. Areas not accessible to the rollers shall be graded with rakes and lutes and compacted with mechanical tampers. For depressed areas a trench roller may be used to achieve the required compaction.

- E. Any asphalt concrete mixture that becomes loose and broken segregated, mixed with dirt, or is any other way defective shall be removed and replaced with fresh hot asphalt concrete mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt cement shall be removed and replaced.
- F. Rollers or other vehicles shall not be parked or left standing on pavement that has not cooled sufficiently to prevent indentation by wheels.

### 3.10 JOINTS

- A. Joints shall be made to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.
- B. When joining old existing pavement and new pavement, the old pavement shall be cut in a neat line, with a power driven saw. All saw cuts on the Project shall be sealed with hot asphalt sealant.
- C. Improperly formed joints resulting in surface irregularities or rock segregation shall be removed, full road width, replaced with new material, and thoroughly compacted. Rolling of joints after the material has cooled below 160°F shall not be allowed. All pavement removal shall be precut to a neat line using a power driven saw.
- D. A thin tack coat of asphalt cement or asphalt emulsion shall be applied on all cold joints prior to placing any fresh asphalt concrete mixture against the joint. This WORK shall be completed by the CONTRACTOR just prior to paving.
- E. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course or by using a removable bulkhead.
- F. The longitudinal joints in one layer shall offset those in the layer immediately below by at least six (6) inches. The joints in the top layer shall be at centerline or lane lines except where pre-formed marking tape striping is required, in which case the longitudinal joint in the top layer shall be offset not more than one (1) foot.
- G. The density at the joints shall not be more than 2% lower than the density specified in the lanes away from the joint.
- H. Rolling at the longitudinal joint should be done from the hot side with a vibratory roller as soon as possible. The hot side should always overlap the cold side by 1 to 1.5 inches at the joint.
- I. The finished asphalt surface along the edge of catch curb and gutter shall be ¼ inch above the top edge of the gutter pan.
- J. All joints with existing asphalt pavement shall be resealed with PG 58-22 asphalt cement after the new pavement has cooled to ambient temperature. All joints with concrete gutters found to have a gap shall be blown out using a weed burner torch, filled with PG 58-22 asphalt cement and covered with a layer of dry sand. Excess sand shall be removed and asphalt cement placed on the concrete gutter more than one-inch from the edge of gutter shall be removed using solvent or other approving methods.

### 3.11 SURFACE TOLERANCE

- A. The surface will be tested after final rolling at selected locations using a ten (10) foot straightedge. The variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall not exceed 3/16 inch. The asphalt concrete mixture in all defective areas shall be removed and replaced. All costs associated with removal and replacement of asphalt concrete mixture in the defective areas shall be borne by the CONTRACTOR.
- B. All asphalt surfaces segregated with single large stones void of intermediate aggregate on the surface shall be removed and replaced full lane width. The surface particles shall be consistent and conform to the contract gradation.

### 3.12 PATCHING DEFECTIVE AREAS

- A. Any asphalt concrete mixture that becomes contaminated with wood or foreign material or is in any way defective shall be removed. Defective materials shall be removed for the full thickness of the course. The pavement shall be saw cut so that the sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be coated with a thin tack coat material in accordance with Section 321217 – Tack Coat. Fresh asphalt concrete mixture shall be placed in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. The asphalt concrete mixture shall be compacted to the density specified. No payment shall be made for material replacing defective material. All costs associated with the patching of defective areas shall be borne by the CONTRACTOR.

### 3.13 ACCEPTANCE SAMPLING AND TESTING

- A. Asphalt concrete pavement will be accepted for payment based on the DEPARTMENT's approval of: the Job Mix Design; the materials; the placement and compaction of the asphalt concrete pavement to the specified depth, finished surface requirements, tolerances, and densities. Any area of finished surfacing that is visibly segregated, fails to meet surface tolerance requirements or specified thickness or densities, or is in any way defective, shall be removed and replaced with new asphalt concrete pavement. Removal and replacement of defective pavement shall be at no additional cost to the DEPARTMENT. The full depth of the new asphalt concrete mixture will be replaced: surface patching will not be allowed.
- B. Acceptance sampling and testing shall be performed by the DEPARTMENT. Acceptance testing will determine whether the materials, installation and compaction efforts used by the CONTRACTOR have met these specifications. The results of the acceptance testing performed by the DEPARTMENT may not be available to the CONTRACTOR until a period of at least seven working days has elapsed from the date of sampling.
- C. A lot will be the total asphalt placed on the Project per season. A subplot will be one Day's production on the Project. Each subplot shall be randomly sampled and tested in accordance with this Subsection for asphalt cement content, maximum specific gravity using the Rice Method, density, and gradation.
- D. Samples taken for the determination of asphalt cement content and gradation will be taken from behind the screed prior to initial compaction. Asphalt cement content shall be determined by ATM T-23. The cost of this sampling (one per subplot) will be borne by the DEPARTMENT. The CONTRACTOR shall pay for additional testing if not in compliance.

- E. ASTM D-2950 will be used to measure density. A minimum of six (6) random tests in locations determined by the DEPARTMENT will be taken from each subplot. When using ASTM D-2950, the MSG or laboratory pounds per cubic feet shall be determined by using the Rice Method, AASHTO T 209. The Rice Method, for the purposes of nuclear gauge compaction testing, replaces the Marshal Method. Acceptance testing for density will be completed by the DEPARTMENT in the following sequence:
1. The DEPARTMENT will randomly sample the in-place asphalt concrete mixture with a nuclear densometer gauge. Random is defined as having no specific pattern. Frequency of this testing will be determined by the DEPARTMENT. The CONTRACTOR may request a re-test of any nuclear densometer sample not within Specification limits. The DEPARTMENT will select the sample location for the re-test. Only one (1) re-test per sample will be allowed. This acceptance testing will be paid for by the DEPARTMENT.
  2. If the random density acceptance testing indicates that the density specified has not been met, further sampling and testing will be required by the DEPARTMENT. At the direction of the DEPARTMENT, the CONTRACTOR shall cut at least one (1) full depth six (6) inch diameter core sample (per lot) from the finished mat. The samples shall be neatly cut by a core drill at the randomly selected locations. Core holes for sampling shall be backfilled and compacted with hot asphalt concrete mixture within two (2) hours of sampling. The core samples will be tested for compliance with these specifications at a certified laboratory specified by the DEPARTMENT. Any sampling and testing required beyond the nuclear densometer testing by the DEPARTMENT will be paid by the CONTRACTOR.
- F. At the direction of the DEPARTMENT, samples taken for the determination of aggregate gradation may be obtained from one (1) of the following locations:
1. From the combined aggregate cold feed conveyor via a diversion chute, or from the stopped conveyor belt.
  2. For dry batched aggregates, on batch plants, the pugmill shall be cleaned by dry batching at least two (2) dry batches or until no asphalt coating is found on the aggregate. One complete batch will be dropped in a loader bucket and hand mixed thoroughly with a shovel until a sample can be taken. The sample will be used for acceptance, gradation, control, and payment.
- G. Additional materials testing will be required whenever a new Trial Job Mix Design is approved. The maximum specific gravity (MSG) for each lot will be determined from the first randomly selected sample from the first subplot. Material testing includes, but is not limited to, gradations, extractions, density testing and core analysis.
- H. If field density is determined in accordance with ASTM D-2950, additional core samples will be required whenever a new Trial Job Mix Design is approved or whenever there is a change in the typical section. The MSG for each lot will be determined from the first randomly selected sample from the first subplot. The CONTRACTOR shall reimburse the DEPARTMENT for all materials testing beyond the first \$2,000.00. Material testing includes but is not limited to gradations, extractions, density testing and core analysis.
- I. All tests necessary to determine conformance with the requirements specified in this Section will be performed by the DEPARTMENT and paid for by the CONTRACTOR.

- J. The frequency of materials testing for asphalt is determined by the DEPARTMENT Materials Frequency Guide. The DEPARTMENT Inspector shall meet with the Project Manager prior to paving in order to determine the appropriate testing frequency. The latest edition of the Alaska Department of Transportation and Public Facilities Standard Specifications for Highway Construction shall be used and incorporated by reference herein.

**END OF SECTION**

**SECTION 32 12 17  
TACK COAT**

**PART 1- GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and applying bituminous material to an existing asphalt surface to provide bond for a new asphalt wearing surface.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Asphalt material used for tack coat shall be STE-1 or CCS-1 Cationic Emulsified Asphalt, conforming to the requirements of the following table:

**CCS-1/STE-1 CATIONIC EMULSIFIED ASPHALT**

<b>TESTS ON EMULSION</b>	
Viscosity @ 77°F., SSF	30 max.
Storage Stability, One (1) day, %	One (1) max.
Demulsibility 35 ml. 0.8% SDS, %	25 min.
Particle Charge	Positive *
Sieve, % retained	0.10 max.
Distillation Oil by Vol. Of Emulsion, %	Five (5) max.
Distillation Residue by Wt. Of Emulsion, %	45 min.
<b>TESTS ON RESIDUE</b>	
Penetration @ 77° F.	100-200
Ductility @ 77°F., 5cm/min., cm	40 min
Solubility in TCE, %	97.5 min.

\* If particle charge test is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

Storage/Application	Spray °F	Mix °F	Storage °F
Limitations for STE-1	70-140	70-150	50-125
Limitations for CCS-1	70-140	70-160	50-125

**PART 3 - EXECUTION**

**3.01 EQUIPMENT**

- A. The CONTRACTOR shall provide equipment for heating and applying the Tack Coat.

### 3.02 CONSTRUCTION

- A. The existing surface shall be patched, thoroughly cleaned, and free of irregularities to provide a reasonably smooth and uniform surface to receive the treatment. Unstable corrugated areas shall be removed and replaced with suitable patching materials. The edges of existing pavements, which are to be adjacent to new pavement, shall be cleaned to permit the adhesion of asphalt materials.
- B. Tack Coat shall not be applied to a wet surface. Tack Coat shall be applied only when the air temperature is above 40°F.
- C. CSS-1 emulsified asphalt for tack coat shall be diluted with an equal amount of potable water at a temperature of between 50°F and 102°F and mixed for a minimum of 15 minutes before using.
- D. Diluted emulsion shall be used within 48 hours after the water is added.
- E. The diluted emulsion shall be uniformly applied with a pressure distributor at a rate of 0.05 to 0.10 gallons per square yard, as directed.
- F. The Tack Coat shall be applied in such a manner as to offer the least inconvenience to traffic and to permit one-way traffic without pick-up, or tracking of the asphalt material.
- G. Existing improvements such as the rigid conduit, power supply cable, concrete encasement and centerline light shall be protected to prevent contact with bituminous material. The Tack Coat shall be allowed to dry until it is in a proper condition of tackiness to receive the next course. The Tack Coat shall be applied only as far in advance of the next course placement as is necessary to obtain this proper condition of tackiness. Until the next course is placed, the CONTRACTOR shall protect the Tack Coat from damage.
- H. STE-1 cationic asphalt shall not be diluted.

**END OF SECTION**

**SECTION 32 12 18  
REMOVE EXISTING ASPHALT SURFACING**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary to remove existing asphalt surfacing as shown on the Drawings, or as directed by the DEPARTMENT.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. All materials shall conform to the requirements of the Specifications or to the requirements of the agency having jurisdiction over the pavement being replaced.

**PART 3 – EXECUTION**

**3.01 GENERAL**

- A. Asphalt Pavement to be removed shall be neatly saw cut full depth along straight lines, with a tolerance of 0.1 feet in 50 feet and 0.2 feet in 100 feet. Only such pavement shall be removed as is necessary to excavate for the appurtenances, but the pavement shall be cut a sufficient distance outside the excavation to prevent damage to adjacent pavement by lifting or tearing the mat. All removed pavement shall be disposed off of the Project at an approved disposal site.
- B. The CONTRACTOR shall deliver the removed asphalt surfacing material to the asphalt disposal stockpile in the CBJ/State Lemon Creek Gravel Pit. The CONTRACTOR shall stack the material with a loader if required by the DEPARTMENT.
- C. If the CONTRACTOR fails to comply with the provisions of any CBJ ordinance, State Statute or permit pertaining to waste disposal or disposal sites; the DEPARTMENT shall have the right, after giving 30 days written notice, to bring the disposal sites into compliance and collect the cost of the WORK from the CONTRACTOR, either directly or by withholding monies otherwise due under the contract.
- D. Use of grinding or milling equipment will be allowed to remove existing asphalt under the requirements of this section. Pavement grindings from this Project shall be disposed of at the CBJ asphalt disposal area in Lemon Creek pit area. Grindings shall not be reused on the Project.

**END OF SECTION**

**SECTION 32 13 13  
SITE CONCRETE**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing portland cement concrete for site concrete structures in conformance with the Drawings and Specifications.

**PART 2 - PRODUCTS**

**2.01 PORTLAND CEMENT**

- A. Portland cement shall conform to the requirements of AASHTO M 85.
- B. Unless otherwise permitted by the DEPARTMENT, the product from only one mill and one brand and type of portland cement shall be used on the Project.

**2.02 FINE AGGREGATE**

- A. Fine aggregate for portland cement concrete shall conform to the requirements of AASHTO M 6 with the following exceptions:

Delete section on deleterious substances and substitute the following:

The amount of deleterious substances shall not exceed the following limits:

- Friable particles percent by weight ..... 5 max.
- Coal and Lignite, percent by weight using a liquid of 1.95 specific gravity (only material that is brownish-black shall be considered as coal or lignite).... 0.5 max.
- Material passing the No. 200 sieve, percent by weight..... 3.0 max.

Delete paragraph 4.2 of AASHTO M 6.

**2.03 COARSE AGGREGATE**

- A. Coarse aggregate for portland cement concrete shall conform to the requirements of AASHTO M 80, class A, with the following exceptions:

Delete section on deleterious substances and substitute the following:

The amount of deleterious substances shall not exceed the following limits:

- Coal and Lignite, percent by weight (only material that is brownish-black or black shall be considered coal or lignite)..... 1.0 max.
- Material passing the No. 200 sieve ..... 1.0 max
- Thin-elongated pieces, percent by weight. (Length greater than five (5) times average thickness)..... 15 max.
- Sticks and roots, percent by weight.....0.10 max.

Friable Particles, percent by weight .....0.25 max.  
Maximum loss from AASHTO T 96 shall be 50 percent.  
Maximum loss from AASHTO T-104 shall be 12 percent.

## **2.04 JOINT FILLERS**

- A. Joint filler, of the type designated in the contract, shall conform to the following:
1. Poured filler shall conform to AASHTO M 173 or AASHTO M 282 as specified.
  2. Preformed fillers shall conform to AASHTO M 33 for bituminous type; AASHTO M 153 for sponge rubber (type I), cork (type II), and self-expanding cork (type III); AASHTO M 213 for nonextruding and resilient bituminous types and resilient bituminous types and AASHTO M 220 for pre-formed elastomeric types as specified.
  3. AASHTO M 220 for preformed elastomeric types as specified. The filler shall be punched to admit the dowels where called for on the Drawings. Joint filler shall be furnished in a single piece for the depth and width required for the joint unless otherwise authorized by the DEPARTMENT. When more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape, by stapling or other positive fastening satisfactory to the DEPARTMENT.
  4. Foam filler shall be expanded polystyrene filler having a compressive strength of not less than 10 psi.
  5. Hot -poured sealants for concrete and asphaltic pavements shall conform to ASTM D 3405.
  6. Hot-poured elastomeric type sealant for concrete pavements shall conform to ASTM D 3406.
  7. Cold-poured silicone type sealant for concrete pavements shall conform to Federal Specification TT-S-1543, Class A. The sealant shall be a one part, low-modulus silicone rubber with an ultimate elongation of 1,200 percent.

## **2.05 CURING MATERIAL**

- A. Curing material shall conform to the following requirements as specified:
1. Burlap Cloth made from Jute Kenaf AASHTO M 182.
  2. Sheet Material for Curing Concrete AASHTO M 171.
  3. Liquid Membrane-Forming Compounds AASHTO M 148 for Curing Concrete, Type I.
- B. The requirements specified in AASHTO M 148 covering "Liquid Membrane-Forming Compounds for Curing Concrete" are modified by adding the following:
1. Liquid membrane-forming compounds utilizing linseed oil shall not be used.

## **2.06 AIR ENTRAINING AGENTS**

- A. Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

## **2.07 MIXING WATER**

- A. Unless otherwise permitted in writing by the DEPARTMENT, all water shall be obtained from the CBJ potable water system.

## 2.08 REINFORCING STEEL

- A. Reinforcing shall conform to AASHTO M 31, and be of grade 60 or the grade designated on the Drawings or in the Specifications. Welded wire fabric shall conform to AASHTO M 55. Epoxy coated reinforcing bars shall conform to AASHTO M 284.

## 2.09 SHIPPING AND STORAGE OF CEMENT

- A. Cement may be shipped from pretested approved bins. The cement shall be well protected from rain and moisture. Any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the WORK.
- B. Cement stored by the CONTRACTOR for a period longer than 60 days in other than sealed bins or silos shall be retested before being used. Cement of different brands, types, or from different mills shall be stored separately.

## 2.10 COMPOSITION OF CONCRETE

- A. All portland cement concrete shall be ready-mix, provided by an approved plant regularly engaged in the production of concrete, unless otherwise authorized in writing by the DEPARTMENT. Ready-mix concrete shall conform to the requirements of AASHTO M 157.
- B. The CONTRACTOR shall furnish the mix design to the DEPARTMENT for approval. The mix design shall be suitable for its intended use. Concrete shall be designed using an absolute volume analysis. The CONTRACTOR shall be responsible for having each mix design tested at a laboratory. Prior to the start of production of any mix design, the CONTRACTOR shall submit test results and certifications for all materials, detailed mix design data and results of laboratory tests to the DEPARTMENT for approval. Approval by the DEPARTMENT will be based on apparent conformity to these Specifications. It shall remain the CONTRACTOR's responsibility during production to produce concrete conforming to the mix design and the minimum acceptance criteria in the contract. When requested by the DEPARTMENT, the CONTRACTOR shall submit samples of all materials for verification testing. Production shall not commence until the mix design is approved by the DEPARTMENT.
- C. Unless otherwise specified the design mix shall meet the following:

Minimum cement content	6 1/2 sacks (611 lb.) per C.Y.
Maximum water/cement ratio	5.75 gal/sack (0.51 ##/##)
28-day compressive strength (fc) as indicated on Drawings.	
Slump	3" ± 1"
Entrained Air	3 to 6%
Coarse Aggregate	AASHTO M 43, Gradation No. 67
Cement factors are based on 94-pound sacks	
- D. The CONTRACTOR shall be responsible for producing and placing specification concrete with a cement content within a tolerance of two percent.
- E. The use of superplasticizers in the concrete mix to improve the workability of mixes with low water cement ratios will require prior written approval by the DEPARTMENT.
- F. The CONTRACTOR may, subject to prior approval in writing, use alternative sizes of coarse aggregate as shown in Table 1 of AASHTO M 43. If the use of an alternative size of coarse aggregate produces concrete which exceeds the permissible water-cement

ratio above, thereby requiring additional cement above that specified, no compensation will be made to the CONTRACTOR for the additional cement.

## **2.11 SAMPLING AND TESTING**

- A. Field tests of all materials will be made by the DEPARTMENT when deemed necessary, in accordance with the applicable Specifications. When the results of the field tests indicate the material does not conform to the requirements of the Specifications, the re-tests required by the DEPARTMENT shall be at the CONTRACTOR's expense.
- B. Materials which fail to meet contract requirements, as indicated by laboratory tests, shall not be used in the WORK. The CONTRACTOR shall remove all defective materials from the site.
- C. Types and sizes of concrete specimens shall be in accordance with ASTM C 31. Additional slump tests and/or test cylinders may be required at the discretion of the DEPARTMENT. Should the analysis of any test cylinder not meet the preceding requirements of Article 2.10 (Composition of Concrete) its representative concrete shall be removed and replaced at the CONTRACTOR's expense.
- D. Three copies of all test reports shall be furnished to the DEPARTMENT.

## **2.12 COLD WEATHER CONCRETE**

- A. Concrete shall not be placed when the descending air temperature in the shade, away from artificial heat, falls below 40°F. Placement of concrete shall not resume before the ascending air temperature reaches 35°F, without specific written authorization. When the air temperature falls below 40°F, or is, in the opinion of the DEPARTMENT, likely to do so within a 24 hour period after placing concrete, the CONTRACTOR shall have ready on the job materials and equipment required to heat mixing water and aggregate and to protect freshly placed concrete from freezing.
- B. Concrete placed at air temperatures below 40°F shall have a temperature not less than 50°F nor greater than 70°F when placed in the forms. These temperatures shall be obtained by heating the mixing water and/or aggregate. Mixing water shall not be heated to more than 160°F.
- C. Binned aggregates containing ice or in a frozen condition will not be permitted nor will aggregates which have been heated directly by gas or oil flame or heated on sheet metal over an open fire. When aggregates are heated in bins, only steam-coil or water-coil heating will be permitted, except that other methods, when approved, may be used. If live steam is used to thaw frozen aggregate piles, drainage times comparable to those applicable for washed aggregates shall apply.
- D. When the temperature of either the water or aggregate exceeds 100°F, they shall be mixed together so that the temperature of the mix does not exceed 80°F at the time the cement is added.
- E. Any additives must have prior approval of the DEPARTMENT before being used.
- F. The use of calcium chloride is prohibited.
- G. When placing concrete in cold weather, the following precautions shall be taken in addition to the above requirements:

1. Heat shall be applied to forms and reinforcing steel before placing concrete as required to remove all frost, ice, and snow from all surfaces which will be in contact with fresh concrete.
  2. When fresh concrete is to be placed in contact with hardened concrete, the surface of the previous pour shall be warmed to at least 35°F, thoroughly wet, and free water removed before fresh concrete is placed.
  3. When Type I or II cement is used, freshly placed concrete shall be maintained at a temperature of not less than 70°F for three days or not less than 50°F for five days. When Type III cement is used, freshly placed concrete shall be maintained at a temperature of not less than 70°F for two days or not less than 50°F for three days.
  4. The above requirements are not intended to apply during the normal summer construction season when air temperatures of 40°F or higher can reasonably be anticipated during the two-week period immediately following concrete placement, or until the concrete is no longer in danger from freezing.
- H. When temperatures below 20°F are not expected during the curing period and, in the opinion of the DEPARTMENT, no other adverse conditions, such as high winds, are expected, concrete temperatures may be maintained in thick concrete sections by retention of heat of hydration by means of adequately insulated forms.
- I. When, in the opinion of the DEPARTMENT, greater protection is required to maintain the specified temperature, the fresh concrete shall be completely enclosed and an adequate heat source provided. Such enclosure and heat source shall be so designed that evaporation of moisture from the concrete during curing is prevented. Precautions shall be taken to protect the structure from overheating and fire.
- J. At the end of the required curing period protection may be removed, but in such a manner that the drop in temperature of any portion of the concrete will be gradual and not exceed 30°F in the first 24 hours.
- K. For concrete placed within cofferdams and cured by flooding with water, the above conditions may be waived provided that the water in contact with the concrete is not permitted to freeze. De-watering shall not be carried out until the DEPARTMENT determines that the concrete has cured sufficiently to withstand freezing temperatures and hydrostatic pressure.
- L. The CONTRACTOR shall be wholly responsible for the protection of the concrete during cold weather operations. Any concrete injured by frost action or overheating shall be removed and replaced at the CONTRACTOR's expense.

## 2.13 FORMS

- A. Forms shall be so designed and constructed that they may be removed without injuring the concrete.
- B. Unless otherwise specified, forms for exposed surfaces shall be made of plywood, hard-pressed fiberboard, sized and dressed tongue-and-groove lumber, or metal in which all bolt and rivet holes are countersunk, so that a plane, smooth surface of the desired contour is obtained. Rough lumber may be used for surfaces that will not be exposed in the finished structure. All lumber shall be free from knotholes, loose knots, cracks, splits, warps, or other defects affecting the strength or appearance of the finished structure. All forms shall be mortar tight, free of bulge and warp, and shall be cleaned thoroughly before reuse.

- C. In designing forms and falsework, concrete shall be regarded as a liquid. In computing vertical loads a weight of 150 pounds per cubic foot shall be assumed. The lateral pressure for design of wall forms shall not be less than that given by the following formulas:

For walls with R less than or equal to 7 feet per hour:

$$P=150 + \frac{9000R}{T}, \text{ but not more than 2000 p.s.f. or } 150 \text{ h, whichever is less.}$$

For walls with R greater than 7 feet per hour:

$$P=150 + \frac{43,400}{T} + \frac{2800R}{T}, \text{ but not more than 2000 p.s.f. or } 150 \text{ h, whichever is less.}$$

Where:

P = lateral pressure for design of wall forms, p.s.f.

R = rate of placement, feet per hour

T = temperature of concrete in forms, °F

h = maximum height of fresh concrete in form, feet.

- D. The above formulas apply to internally vibrated concrete placed at 10 feet per hour or less, without the use of retarding agents, and where depth of vibration is limited to four feet below the top of the concrete surface. The CONTRACTOR shall state the placement rate and minimum concrete temperature on the working drawings for concrete form WORK. Deflection of plywood, studs, and walers shall not exceed 1/360 of the span between supports.
- E. Forms shall be so designed that placement and finishing of the concrete will not impose loads on the structure resulting in adverse deflections or distortions.
- F. The forms shall be so designed that portions covering concrete that is required to be finished may be removed without disturbing other portions that are to be removed later. As far as practicable, form marks shall conform to the general lines of the structure.
- G. When possible, forms shall be day-lighted at intervals not greater than 10 feet vertically, the openings being sufficient to permit free access to the forms for the purpose of inspecting, and working.
- H. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least one inch from the face without injury to the concrete. All fittings for metal ties shall be of such design that, upon their removal, the cavities which are left will be of the smallest possible size.
- I. All exposed edges 90° or sharper shall be chamfered 3/4 inch unless otherwise noted. Chamfering of forms for re-entrant angles shall be required only when specifically indicated on the Drawings.
- J. Forms shall be inspected immediately prior to the placing of concrete. Dimensions shall be checked carefully and any bulging or warping shall be remedied and all debris and standing water within the forms shall be removed. Special attention shall be paid to ties and bracing and where forms appear to be braced insufficiently or built unsatisfactorily, either before or during placing of the concrete, the DEPARTMENT shall order the WORK stopped until the defects have been corrected.

- K. Forms shall be constructed true to line and grade. Clean-out ports shall be provided at construction joints.
- L. All forms shall be installed in accordance with approved fabrication and erection plans.
- M. All porous forms shall be treated with non-staining form oil or saturated with water immediately before placing concrete.
- N. Falsework shall be built to carry the loads without appreciable settlement. Falsework that cannot be founded on solid footings must be supported by ample falsework piling. Falsework shall be designed to sustain all imposed loads.
- O. Detail drawings of the falsework shall be submitted for review, but such review shall not relieve the CONTRACTOR of any responsibility under the contract for the successful completion of the structure.
- P. Forms and falsework shall not be removed without the consent of the DEPARTMENT. The DEPARTMENT's consent shall not relieve the CONTRACTOR of responsibility for the safety of the WORK. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete.
- Q. To facilitate finishing, forms used on exposed vertical surfaces shall be removed in not less than 12, nor more than 48 hours, depending upon weather conditions.

### **PART 3 - EXECUTION**

#### **3.01 GENERAL**

- A. All concrete shall be placed before it has taken its initial set and, in any case, within 30 minutes after mixing. Concrete shall be placed in such a manner as to avoid segregation of coarse or fine portions of the mixture, and shall be spread in horizontal layers when practicable. Special care shall be exercised in the bottom of slabs and girders to assure the working of the concrete around nests of reinforcing steel, so as to eliminate rock pockets or air bubbles. Enough rods, spades, tampers and vibrators shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches.
- B. Extra vibrating shall be done along all faces to obtain smooth surfaces. Care shall be taken to prevent mortar from splattering on forms and reinforcing steel and from drying ahead of the final covering with concrete.
- C. Concrete shall not be placed in slabs or other sections requiring finishing on the top surface when precipitation is occurring or when in the opinion of the DEPARTMENT precipitation is likely before completion of the finishing, unless the CONTRACTOR shall have ready on the job all materials and equipment necessary to protect the concrete and allow finishing operations to be completed.
- D. Troughs, pipes, or short chutes used as aids in placing concrete shall be arranged and used in such a manner that the ingredients of the concrete do not become separated. Where steep slopes are required, troughs and chutes shall be equipped with baffle boards or shall be in short lengths that reverse the direction of movement. All chutes, troughs, and pipe shall be kept clean and free of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Troughs and chutes shall be of steel or plastic or shall be lined

with steel or plastic and shall extend as nearly as possible to the point of deposit. The use of aluminum for pipes, chutes or tremies is prohibited. When discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

- E. Dropping the concrete a distance of more than five (5) feet or depositing a large quantity at any point and running or working it along the forms will not be permitted. The placing of concrete shall be so regulated that the pressures caused by wet concrete shall not exceed those used in the design of the forms.
- F. High frequency internal vibrators of either the pneumatic, electrical, or hydraulic type shall be used for compacting concrete in all structures. The number of vibrators used shall be ample to consolidate the fresh concrete within 15 minutes of placing in the forms. In all cases, the CONTRACTOR shall provide at least two concrete vibrators for each individual placement operation (one may be a standby), which shall conform to the requirements of these Specifications. Prior to the placement of any concrete, the CONTRACTOR shall demonstrate that the two vibrators are in good working order and repair and ready for use.
- G. The vibrators shall be an approved type, with a minimum frequency of 5,000 cycles per minute and shall be capable of visibly affecting a properly designed mixture with a one inch slump for a distance of at least 18 inches from the vibrator.
- H. Vibrators shall not be held against forms or reinforcing steel nor shall they be used for flowing the concrete or spreading it into place. Vibrators shall be so manipulated as to produce concrete that is free of voids, is of proper texture on exposed faces, and of maximum consolidation. Vibrators shall not be held so long in one place as to result in segregation of concrete or formation of laitance on the surface.
- I. Concrete shall be placed continuously throughout each section of the structure or between indicated joints. If, in any emergency, it is necessary to stop placing concrete before a section is completed, bulkheads shall be placed as the DEPARTMENT may direct and the resulting joint shall be treated as a construction joint.
- J. The presence of areas of excessive honeycomb may be considered sufficient cause for rejection of a structure. Upon written notice that a given structure has been rejected, the rejected WORK shall be removed and rebuilt, in part or wholly as specified, at the CONTRACTOR's expense.

### **3.02 PUMPING CONCRETE**

- A. Concrete may be placed by pumping if the CONTRACTOR demonstrates that the pumping equipment to be used will effectively handle the particular class of concrete with the slump and air content specified and that it is so arranged that no vibrations result that might damage freshly placed concrete. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced.
- B. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned. Slump tests shall be taken at the discharge end of the pipe.

### **3.03 EXPANSION JOINTS**

- A. Expansion joints shall be located and formed as required on the Drawings.

- B. Open Joints. Open joints shall be placed in the location shown on the Drawings and shall be formed. The form shall be removed without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint, unless so specified on the Drawings.
- C. Filled Joints. Unless otherwise shown on the Drawings, expansion joints shall be constructed with pre-molded expansion joint filler with a thickness equal to the width of the joint.
- D. The joint filler shall be cut to the same shape and size as the adjoining surfaces. It shall be fixed firmly against the surface of the concrete already in place in such manner that it will not be displaced when concrete is deposited against it.
- E. Immediately after the forms are removed, the expansion joints shall be inspected carefully. Any concrete or mortar that has sealed across the joint shall be removed.
- F. Joint sealer for use in deck joints shall be of the type shown on the Drawings conforming to the requirements of Article 2.4 (Joint Filler) of this Section. The faces of all joints to be sealed shall be free of foreign matter, paint, curing compound, oils, greases, dirt, free water, and laitance.
- G. Elastomeric Compression Seals. The joint seal shall be shaped as shown on the Drawings. It shall be installed by suitable hand or machine tools and thoroughly secured in place with a lubricant-adhesive recommended by the seal manufacturer. The lubricant-adhesive shall cover both sides of the seal over the full area in contact with the sides of the joint.
- H. The seal shall be in one piece for the full width of the joint. Any joints at curbs shall be sealed adequately with additional adhesive.
- I. The seal may be installed immediately after the curing period of the concrete. Temperature limitations of the lubricant-adhesive as guaranteed by the manufacturer shall be observed.
- J. Strip Seals. Expansion joint strip seals shall be as shown on the Drawings, and composed of a steel extrusion and an extruded strip seal. The steel shall conform to ASTM A242 or A588. Strip seals shall be one piece for the length of the joint.
- K. Installation of the expansion joints shall be in accordance with the manufacturer's recommendations, except that the joint opening shall be adjusted for the dimensions indicated on the Drawings.

### **3.04 PIPES, CONDUITS, AND DUCTS**

- A. Pipes, conduits, and ducts that are to be encased in concrete shall be installed in the forms by the CONTRACTOR before the concrete is placed. Unless otherwise indicated, they shall be standard, lightweight cast-iron water pipe or wrought iron. They shall be held rigidly so they will not be displaced during concrete placement.

### **3.05 FINISHING CONCRETE SURFACES**

- A. All concrete surfaces exposed in the completed WORK shall receive an Ordinary Finish, as described below, unless otherwise noted on the Drawings or in the special provisions.

### 3.06 ORDINARY FINISH

- A. An Ordinary Finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes left by form ties, and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections. All surfaces that cannot be satisfactorily repaired shall be given a Rubbed Finish.
- B. The concrete in caps and tops of walls shall be struck off with a straightedge and floated to true grade. The use of mortar topping for concrete surfaces shall in no case be permitted.
- C. As soon as the forms are removed, metal devices that have been used for holding the forms in place, and which pass through the body of the concrete, shall be removed or cut back at least one inch beneath the surface of the concrete. Fins of mortar and all irregularities caused by form joints shall be removed.
- D. All small holes, depressions, and voids that show upon the removal of forms, shall be filled with cement mortar mixed in the same proportions as that used in the body of the WORK. In patching larger holes and honeycombs, all coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with stiff mortar composed of one part portland cement to two parts sand, which shall be thoroughly tamped into place. The mortar shall be pre-shrunk by mixing it approximately 20 minutes before using. The length of time may be varied in accordance with brand of cement used, temperature, humidity, and other local conditions. The surface of this mortar shall be floated with a wooden float before initial set takes place and shall be neat in appearance. The patch shall be kept wet for a period of five days.
- E. For patching large or deep areas, coarse aggregate shall be added to the patching material. All mortar for patching on surfaces which will be exposed to view in the completed structure shall be color matched to the concrete. Test patches for color matching shall be conducted on concrete that will be hidden from view in the completed WORK and shall be subject to approval.

### 3.07 RUBBED FINISH

- A. When forms can be removed while the concrete is still green, the surface shall be pointed and wetted and then rubbed with a wooden float until all irregularities and form marks are removed and the surface is covered with a lather composed of cement and water. This lather shall be allowed to set for at least five days. The surface shall then be smoothed by being rubbed lightly with a fine carborundum stone. If permitted, a thin grout composed of one part cement and one part fine sand may be used in the rubbing.
- B. If the concrete has hardened before being rubbed, a medium coarse carborundum stone shall be used to finish the surface. Such WORK shall not be done until at least four days after placing and it shall be done in the following manner:
  - 1. A thin grout composed of one part cement and one part fine sand shall be spread over a small area of the surface. It shall be rubbed immediately with the stone until all form marks and irregularities are removed and the surface is covered with a lather. The surface shall then be finished as described above for green concrete.

- C. The surface shall be smooth in texture and uniform in appearance. The building up of depressions will not be permitted.
- D. If, through the use of first-class form materials and the exercise of special care, concrete surfaces are obtained that are satisfactory, the CONTRACTOR may be relieved entirely or in part from the requirements for a rubbed finish.

### 3.08 CURING CONCRETE

- A. Water Curing:
  - 1. All concrete surfaces shall be kept wet for at least seven (7) days after placement if Type I or II cement has been used or for three days if Type III cement has been used. Concrete shall be covered with wet burlap, cotton mats, or other materials meeting the requirements of AASHTO M 171 immediately after final finishing of the surface. These materials shall remain in place for the full curing period or they may be removed when the concrete has hardened sufficiently to prevent marring. The surface shall immediately be covered with sand, earth, straw, or similar materials.
  - 2. In either case the materials shall be kept thoroughly wet for the entire curing period. All other surfaces, if not protected by forms, shall be kept thoroughly wet, either by sprinkling or by the use of wet burlap, cotton mats, or other suitable fabric, until the end of the curing period. If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent opening at joints.
- B. Membrane Curing. Liquid membrane curing compound meeting the requirements of AASHTO M 148, Type I, may be permitted, subject to approval by the DEPARTMENT. Compounds utilizing linseed oil shall not be used. All finishing of concrete surfaces shall be performed to the satisfaction of the DEPARTMENT prior to applying the impervious membrane-curing compound. The concrete surfaces must be kept wet with water continuously until the membrane has been applied. The manufacturer's instructions shall be carefully followed in applying the membrane. In all cases, the membrane-curing compound must always be thoroughly mixed immediately before application. If the membrane becomes marred, worn, or in any way damaged, it must immediately be repaired by wetting the damaged area thoroughly and applying a new coat of the impervious membrane-curing compound. Membrane curing will not be permitted for concrete slabs that are to be covered with waterproof membranes, for polymer modified concrete or at construction joints.

### 3.09 BACKFILLING

- A. Unbalanced backfilling against concrete structures will not be permitted until the concrete has attained a compressive strength of not less than 80% of the ultimate strength ( $f'_c$ ) shown on the Drawings.
- B. The compressive strength shall be determined from informational test cylinders cured on the site under similar conditions of temperature and moisture as the concrete in the structure.

**3.10 CLEANING UP**

- A. Upon completion of the structure and before final acceptance, the CONTRACTOR shall remove all falsework. Falsework piling shall be removed or cut off at least two feet below the finished ground line.

**END OF SECTION**

**SECTION 32 13 14  
CONCRETE STRUCTURES**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools, and equipment necessary for furnishing and installing concrete structures in accordance with these Specifications and in reasonably close conformity with the lines, grades, details, and locations shown on the Drawings or directed by the DEPARTMENT.
- B. Civil Concrete Structures are site retaining walls, concrete headwalls, concrete area drains, concrete sidewalks and slabs, concrete terrace walls, thrust blocks and dumpster slab.

**1.03 SUBMITTALS**

- A. Material Certificates: For each of the following, signed by manufacturer:
  - 1. Form-release agents.
  - 2. Joint filler for concrete sidewalk, curbs and site walls.
  - 3. Reinforcing steel shop drawings.
  - 4. Concrete mix design.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Portland Cement shall conform to the requirements of AASHTO M 85.
- B. Aggregate shall be clean, durable, uniformly graded sand and gravel, or crushed stone, 100 percent passing a 1 1/2 inch sieve and containing not more than five percent passing a U.S. No. 200 sieve.
- C. Air-entraining admixtures shall conform to the requirement of AASHTO M 154.
- D. Water shall be obtained from the CBJ potable water system, unless otherwise permitted in writing by the DEPARTMENT.
- E. Curing materials shall conform to the requirements of AASHTO M 182, AASHTO M 171, or AASHTO M 148, as appropriate, except that AASHTO M 148 is modified to prohibit the use of compounds utilizing linseed oil.
- F. Reinforcing Steel shall conform to the requirements of AASHTO M 31.
- G. Welded Wire Fabric shall conform to the requirements of AASHTO M 55.
- H. Joint Fillers shall be of the type specified in the contract, and shall conform to the appropriate following requirements:

1. Poured filler shall conform to AASHTO M 173 or AASHTO M 282 as specified.
2. Hot-poured sealants for concrete and asphaltic pavements shall conform to ASTM D 3405, color gray.
3. Hot-poured elastomeric type sealant for concrete pavements shall conform to ASTM D 3406, color gray.
4. Cold-poured silicone type sealant for concrete pavements shall conform to Federal Specification TT-S-1543, Class A. The sealant shall be one part, low-modulus silicone rubber with an ultimate elongation of 1,200 percent, color gray.
5. Preformed fiber expansion joint fillers shall conform to AASHTO M 213 for non-extruding and resilient bituminous types.

## **2.02 COMPOSITION OF CONCRETE**

- A. Portland cement concrete will ordinarily be accepted on the basis of certification.
- B. The concrete shall contain three to six percent of entrained air, as determined by AASHTO T 152. Concrete shall have a slump of not more than four inches as determined by AASHTO T 119.
- C. Concrete shall contain not less than 611 pounds of cement and not more than 300 pounds of water per cubic yard.
- D. The concrete shall develop a minimum compressive strength of 3,000 psi in 28 days.
- E. The concrete shall be subject to acceptance or rejection by visual inspection at the job site. Re-tempering concrete will not be permitted.
- F. The CONTRACTOR shall submit for approval the following:
  1. The type and sources of aggregates and cement.
  2. Scale weights of each aggregate proposed as pounds per cubic yard of concrete.
  3. Quantity of water proposed as pounds per cubic yard of concrete.
  4. Quantity of cement proposed as pounds per cubic yard of concrete.
  5. Air content.
  6. Slump.
- G. When a commercial supplier is used, the CONTRACTOR shall furnish a certification with each truckload of concrete certifying that the material and mix proportions used are in conformance with the approved mixture.
- H. Concrete complying with Section 321313 – Site Concrete will be acceptable as an approved mixture with appropriate certification.
- I. The DEPARTMENT may make and test cylinders for strength determinations.

## **2.03 FORMS**

- A. Forms shall be designed and constructed to be removed without injuring the concrete. They shall be free of bulge and warp, and constructed so the finished concrete will be of the form and dimensions shown on the Drawings, and true to line and grade. Forms for concrete containing a retarding admixture shall be designed for a lateral pressure equal to that exerted by a fluid weighing 150 pounds per cubic foot.

### **PART 3 - EXECUTION**

#### **3.01 PLACING CONCRETE**

- A. Concrete shall be placed to avoid segregation of materials and shall be consolidated with mechanical vibrators in accordance with Section 321313 – Site Concrete.
- B. When concrete is placed by the pumping method or by tremie operations, the use of aluminum pipe or conduit for transporting the concrete will not be permitted.
- C. The intervals between delivery of batches for a single pour shall not exceed 30 minutes.
- D. When placing concrete at or below an atmospheric temperature of 35°F. the CONTRACTOR shall comply with the applicable requirements of Section 321313 – Site Concrete.

#### **3.02 FINISHING CONCRETE SURFACES**

- A. All concrete surfaces, except exposed glass, shall have an ordinary finish in accordance with the requirements of Section 321313 – Site Concrete, except "Concrete International Corporation" Ashford formula shall be used as a curing compound.

#### **3.03 CURING CONCRETE**

- A. All concrete will be cured a minimum of seven days, or, if high early strength cement is used, a minimum of three days. The concrete shall be cured in accordance with Section 321313 – Site Concrete.

#### **3.04 AS-CAST FORMED FINISHES**

- A. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
  - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

#### **3.05 CONCRETE AREA DRAIN**

- A. Concrete area drains shall conform to the Area Drain Detail shown in the Drawings and the grade lines on each side of the slab, and the depth from the edge of the slab to the grate, shall be as established and approved by the DEPARTMENT prior to placing concrete.
- B. The depression of the grate from the top edges of the slab may be as much as 12-inches on one side.

#### **3.06 CONCRETE HEADWALL WITH TRASH RACK**

- A. The headwall and trash rack shall conform to Culvert Headwall with Hinged Trash Rack detail as shown on the Drawings with adjustments to match the site conditions and grades, or as approved by the DEPARTMENT.

**3.07 CONCRETE ACCESS PAD, 6-INCHES THICK, WITH DETECTABLE TILES**

- A. Concrete sidewalk segments, for access pads, shall be constructed as shown on the Drawings at access ramp locations. The concrete pads shall be graded to a 2% maximum slope and shall be 6-inches thick. Detectable tiles shall be installed at each ramp to the dimensions and locations shown on the Drawings. Detectable tiles shall be "Inline Dome-Paver Tiles" from "ADA Solutions," or approved equal. Installation of the detectable tiles shall be in accordance with the manufacturer's recommendations.

**3.08 CONCRETE SITE WALLS**

- A. Concrete Site Walls shall conform to the dimensions shown in the Drawings and shall be constructed with concrete achieving a minimum compressive strength of 3,000 psi after 28 days.
- B. Finishing of the concrete site wall surfaces shall be an ordinary finish. All exposed concrete surfaces will receive Ashford curing compound.

**3.09 CONCRETE TERRACE WALLS**

- A. Concrete Terrace Walls shall conform to the dimensions shown in the Drawings and shall be constructed with concrete achieving a minimum compressive strength of 3,000 psi after 28 days.
- B. Finishing of the Concrete Terrace Walls surfaces shall be an ordinary finish. All exposed concrete surfaces will receive Ashford curing compound.

**END OF SECTION**

**SECTION 32 13 15  
SIDEWALK, CURB AND GUTTER**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools, and equipment necessary for furnishing and installing concrete slabs, sidewalks and curb & gutter as shown on the Drawings.

**1.03 SUBMITTALS**

- A. Samples: For each of the following materials:
  - 1. Sidewalk joint filler.
- B. Technical data sheets for the concrete acrylic fortifier and water based stain resistant sealer.
- C. Construction Joint Layout: Indicate proposed construction joints as indicated in the Drawings and required to construct the Project.
  - 1. Location and layout of joints is subject to the approval of the DEPARTMENT.

**1.04 QUALITY ASSURANCE**

- A. Mockups: Before casting concrete, build mockups to verify selections made under sample submittals and to demonstrate typical joints, surface finish, texture, colors, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed WORK:
  - 1. Build mockups of typical cast-in-place concrete as required for verification, as shown on the Drawings.
  - 2. Obtain DEPARTMENT's approval of mockups before proceeding with casting concrete.

**PART 2 - PRODUCTS**

**2.01 MATERIALS**

- A. Materials shall conform to the requirements of Section 321313 – Site Concrete, except "Concrete International Corporation" Ashford Formula, or approved equal, shall be used instead of the specified curing materials.
- B. Synthetic fibers shall be used for reinforcement with curb and gutter and concrete sidewalk replacements, except a 6-foot length of No. 4 reinforcing bar shall be centered across catch basins centered in the curb.
- C. Joint fillers shall conform to requirements of Section 321313 – Site Concrete.

- D. Synthetic fibers shall be added to concrete at the batch plant with the types and weights as follows:
1. Sidewalk – Fibermesh 150 (formerly Stealth), as manufactured by “SI Concrete Systems,” or approved equal, at 1.5 pounds per cubic yard of concrete.
  2. Curb and Gutter – Fibermesh 300 (fibrillated fibers), as manufactured by “SI concrete Systems,” or approved equal, at 1.5 pounds per cubic yard of concrete.

### **PART 3 - EXECUTION**

#### **3.01 METHODS OF CONSTRUCTION**

- A. Sidewalk, concrete slabs, curb and gutter shall conform to the applicable requirements of Section 321313 – Site Concrete, and as shown on the Drawings, except "Concrete International Corporation" Ashford formula, or approved equal, shall be used as a curing compound.
1. The curing compound shall be sprayed on the surface with a low-pressure sprayer immediately following the finishing operation.
  2. The entire surface shall be kept wet for 30 minutes by brooming excess material onto the dry spots or by re-spraying them immediately. No areas on the concrete surface shall be allowed to dry during the initial 30 minute period.
  3. As the curing compound begins to dry into the surface and becomes slippery, lightly sprinkle the surface with water to aid the penetration of the curing compound and to bring any alkali to the surface.
  4. After 30 to 40 minutes, squeegee or broom the surface to remove any excess curing compound and alkali or other impurities brought to the surface. All WORK required for the application of the curing compound shall conform to the manufacturer's recommendations.
- B. All exposed or unprotected edges of sidewalks shall be tooled to a radius of not more than one-half inch. After floating, trowel finish the entire surface using steel trowels. Final finish shall be obtained by brooming the surface, including the tooled edge, to a gritty finish after all free moisture has disappeared from the surface. Sprinkling of cement or sand for blotting will not be permitted.
- C. Concrete curb and gutter shall be integral, one course construction, and molded in place on a compacted base course. The face forms of the integral curb and gutter shall be removed as soon as practicable. The top and inclined surface shall then be worked with float or steel trowels to a gritty finish. Glazing, sprinkling of sand or cement, or blotting will not be permitted. Both front and back edges shall be tooled to a radius of one-half inch.
- D. Use of monolithic curb and gutter machines will be permitted only with the written approval of the DEPARTMENT. Mortar may be added to the curb machine in a quantity approved by the DEPARTMENT.
- E. Expansion joints shall be placed at a maximum of 30-foot intervals, along all structures and about all features that project into, through, or against the concrete. An expansion joint shall be constructed at the intersection of sidewalks and at the beginning and end of curb returns. Expansion joints shall not be placed between the sidewalk and the curb.
- F. Expansion joint material shall conform to the requirements of AASHTO M 213. This material shall extend the full width of the structure and shall be cut to such dimensions that the base of the expansion joint shall extend to the subgrade and the top shall be

depressed not less than one-quarter inch nor more than one-half inch below the finished surface of the concrete. The material shall be one piece in the vertical dimension and shall be securely fastened to the existing concrete face against which fresh concrete is to be poured.

- G. Joints shall be cleared of all gravel and loose material. Joint surfaces shall be kept clean and dry during sealing. Sealing shall be done in accordance to manufacturer's recommendations. Sealant placed incorrectly shall be removed and replaced at the CONTRACTOR's expense.
- H. Transverse contraction joints, cut to a depth of  $\frac{1}{4}$  of the slab thickness prior to the final set of the concrete. The joints shall be tooled in the sidewalk as shown on the Drawings. Where the sidewalk adjoins the curb (parallel to it), contraction joints in the sidewalk and curb shall be made to match where practicable.
- I. The top and face of the finished curb shall be true and straight and the top surface of curbs shall be of uniform width, free from lumps, sags, or other irregularities. When a straightedge 10 feet long is laid on the top or face of the curb, or on the surface of gutters, the surface shall not vary more than 0.02 foot from the edge of the straightedge except at grade changes or curves. All discolored concrete shall be cleaned at the CONTRACTOR's expense. The concrete may be cleaned by abrasive blast cleaning or other methods approved by the DEPARTMENT. Repairs shall be made by removing and replacing the entire unit between scoring lines or joints.

**END OF SECTION**

**SECTION 32 13 16  
REMOVE EXISTING SIDEWALK, CONCRETE SLAB, OR CURB AND GUTTER**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this section includes providing all labor, materials, tools, and equipment necessary for removing and disposing of existing concrete sidewalks, concrete slabs, concrete curb and gutter, or concrete valley gutter as indicated on the Drawings or as directed by the DEPARTMENT.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

**3.01 CONSTRUCTION**

- A. Sidewalks, concrete slabs, curb and gutter, or valley gutter to be removed shall be separated from the remaining portion by saw cutting. Saw cuts shall be at right angles to the curb, sidewalk, or slab edge. Broken edges shall be trimmed to eliminate jagged or irregular surfaces. The CONTRACTOR shall dispose of the material at an approved disposal area.
- B. The CONTRACTOR is responsible to secure disposal sites, including obtaining written permission from the owner and any required permits, if none are indicated on the Drawings. The cost of securing such sites shall be borne by the CONTRACTOR.

**END OF SECTION**

**SECTION 32 14 00  
UNIT PAVING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes the following:
  - 1. Concrete pavers set in aggregate setting bed.
  - 2. Stone pavers set in mortar setting bed.
  - 3. ADA concrete pavers set in mortar setting bed
  - 4. Edge restraints for unit pavers.
- B. Related sections drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this section.e the following:

**1.02 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Concrete pavers.
  - 2. Stone pavers.
  - 3. ADA pavers.
  - 4. Geotextile.
  - 5. Paver joint sand stabilizer.
- B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
- C. Samples for Verification:
  - 1. Full-size units of each type of paver indicated in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
- D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
  - 1. A copy of paver installation subcontractor's current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.
- E. Compatibility and Adhesion Test Reports: From latex-additive manufacturer indicating the following:
  - 1. Mortar containing latex additives has been tested with pavers for compatibility and adhesion.
  - 2. Interpretation of test results relative to mortar performance and written recommendations for installation practices needed for adhesion.

**1.03 QUALITY ASSURANCE**

- A. Installer Qualifications: An experienced installer who has completed unit paver installations 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.
- B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Pre-construction Coordination: Review installation procedures and coordinate paving work with other work affected by the unit paving work. Prior to beginning construction, coordinate critical dimensions of pavers with flatwork, so that there is minimal paver cutting required. Field verify that layout shown on Drawings coincides with paver critical dimensions by constructing mockup as described below. Submit evidence to Architect that this coordination work has been completed.

- D. Mockups: Before installing unit pavers, build mockups for each form and pattern of pavers required to verify selections made under sample submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work, including same base construction, edging, special features for expansion joints, and contiguous work as indicated:
1. Build mockups in the location as directed by Architect and of approximately 8 foot by 4 foot size.
  2. Build mockups in advance of concrete forms being laid out or constructed, so that the critical dimensions of the unit paving work may be coordinated with the surrounding flatwork.
  3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  4. Demonstrate the proposed range of aesthetic effects and workmanship.
  5. Obtain Architect's approval of mockups before starting paver installation.
  6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  7. Demolish and remove mock-ups when directed.
  8. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### **1.04 DELIVERY, STORAGE, AND HANDLING**

- A. Protect pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
- B. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store liquids in tightly closed containers protected from freezing.

#### **1.05 PROJECT CONDITIONS**

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout: Comply with the following requirements:
  1. Cold-Weather Requirements: Protect paver work against freezing when atmospheric temperature is 40 degrees Fahrenheit and falling. Heat materials to provide mortar temperatures between 40 and 120 degrees Fahrenheit. Provide the following protection for completed portions of work for 24 hours after installation when the mean daily air temperature is as indicated: below 40 degrees Fahrenheit, cover with weather-resistant membrane; below 25 degrees Fahrenheit, cover with insulating blankets; below 20 degrees Fahrenheit, provide enclosure and temporary heat to maintain temperature above 32 degrees Fahrenheit.
  2. Hot-Weather Requirements: Protect paver work when temperature and humidity conditions produce excessive evaporation of setting beds. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 degrees Fahrenheit and higher.
  3. When ambient temperature exceeds 100 or 90 degrees Fahrenheit with a wind velocity greater than 8 mph, set pavers within 1 minute of spreading setting-bed mortar.

### **PART 2 - PRODUCTS**

#### **2.01 PAVERS**

- A. Concrete Pavers:
  1. Requirements: Solid, concrete paving units, ASTM C 936, and resistant to freezing and thawing when tested according to ASTM C 67 made from normal-weight aggregates in

sizes and shapes indicated. Average compressive strength of 8000 PSI with no individual less than 7300 PSI when tested to ASTM C140 standards.

2. The CONTRACTOR is hereby advised that some concrete pavers manufactured and delivered will not be acceptable for use in the Work for any exposed face, edge or corner treatment, and therefore, may require that some of the pavers be rejected for use on this Project.
3. Permissible Extent of Chippage from Edges and Corners: 1/16 inch. The cumulative length of chips on the exposed face of a single unit shall not exceed 1 percent of the perimeter of the exposed face of the paver, and no single chip shall exceed 1/8 inch in length.
4. Other than chips, the paver shall be free of cracks, color and other imperfections detracting from the appearance of a designated sample when viewed from a distance of 5 feet.
5. Concrete pavers that show significant amount of efflorescence will be rejected, removed from the site, and replaced at no additional cost to the Owner.

B. Paver Types:

1. Unit Paver Type I (Sand Set):
  - a. Manufacturer: Willamette Grey Stone, Hanover Architectural Products or Pavestone.
  - b. Product: Concrete paver
  - c. Style: Rectangular
  - d. Size: 6" x 12" x 80mm
  - e. Color: Tan
  - f. Finish: Shot Blast Finish
2. Unit Paver II (Sand Set):
  - a. Manufacturer: Willamette Grey Stone, Hanover Architectural Products or Pavestone.
  - b. Product: Concrete paver.
  - c. Style: Rectangular.
  - d. Size: 6" x 12" x 80mm
  - e. Color: Charcoal
  - f. Finish: Shot Blast Finish.
3. ADA Paver (Mortar Set):
  - a. Manufacturer: Hanover Architectural Products or Wausau Tile.
  - b. Product: ADA paver.
  - c. Finish: Per manufacturer.
  - d. Size: 12" x 12" x 2".
  - e. Color: Charcoal.
4. Paver (Mortar Set):
  - a. Manufacturer: Cold Spring Granite, Yellow Mountain Granite or NW Granite and Marble.
  - b. Product: Granite paver.
  - c. Special Instructions: provide shop drawings.
  - d. Size: 4" x 4" x 3", cut to fit pattern on plans.
  - e. Color: Black
  - f. Finish: Thermal Finish.

**2.02 ACCESSORIES**

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi, and indicated in the Drawings.
- B. Expansion Joint Material: Sonneborn/ChemRex "Expansion Joint Filler." Preformed: closed-cell polyethylene joint filler designed for use in cold joints, construction joints, or isolation joints wider than 1/4 inch. Comply with ASTM D 1056, Grade 2A1.
- C. Backer Rod: Sonneborn/ChemRex "Sonofoam Soft Backer Rod", non-gassing, reticulated closed-cell polyethylene rod designed for use with cold-applied joint sealants. Comply with ASTM C 1330. Size as required for joint design.

- D. Joint Sealant: Two component, self-leveling, slope-grade elastomeric polyurethane sealant for horizontal joints: Sonneborn/ChemRex "Sonolastic SL 2" with plus or minus 25 percent movement capability for horizontal joints; ASTM C 920, Type M, Grade P, Class 25; FS TT-S-00227E, Type I, Class A. Color to be selected by Architect from Sonneborn's Rainbow of Colors palette.
- E. Sealant Primer: Sonneborn/ChemRex "Primer No. 733" solvent based primer for preparing concrete surfaces for adhesion to sealant.
- F. Joint Cleaner: Non-corrosive and non-staining type recommended by sealant manufacturer and compatible with joint forming materials.
- G. Bond Breaker: 15 pound asphalt impregnated felt.
  - 1. Comply with ASTM D266-97A.
  - 2. Cut into 18 inch wide strips.
  - 3. Install centered over expansion joints and contraction joints in concrete slab.

### **2.03 PAVER JOINT SAND STABILIZER**

- A. Organic joint sand stabilizer additive, Techni-Seal 'RG Polymeric Sand'; Tel.: (800) 363-7500 or equal.

### **2.04 AGGREGATE SETTING-BED MATERIALS**

- A. Dense Graded Aggregate for Subbase: Sound crushed stone or gravel with sieve analysis as determined by AASHTO T-27 shown in Table 1 below, and complying requirements of Division 31 Section "Earth Moving."
- B. Dense Graded Aggregate for Base: Sound crushed stone or gravel with sieve analysis as determined by AASHTO T-27 shown in Table 2 below, and complying requirements of Division 31 Section "Earth Moving."
- C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements of ASTM C-33 shown in Table 3 below, for fine aggregate.
- D. Sand for Joints: Fine, sharp, washed natural sand or crushed stone with sieve analysis as determined by AASHTO T-27 and ASTM C-144, complying with gradation requirements shown in Table 4 below.

Table 1  
Dense Graded Aggregate for Subbase Type C-1 (1-inch to 0)  
Grading Requirements

<u>Sieve Size</u>	<u>Percent Passing</u>
1 1/2 in.	100
1 in.	70 to 100
3/4 in.	60 to 90
3/8 in.	45 to 75
No. 4	30 to 60
No. 8	22 to 52
No. 50	8 to 30
No. 200	0 to 6

Table 2  
Dense Graded Aggregate for Base Type E-1 (3/4 inch to 0)  
Grading Requirements

<u>Sieve Size</u>	<u>Percent Passing</u>
1 in.	100
3/4 in.	70 to 100
3/8 in.	50 to 85
No. 4	35 to 65
No. 8	20 to 50
No. 50	15 to 30
No. 200	8 to 15

Table 3  
Fine Aggregates for Bedding Sand  
Grading Requirements

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 in.	100
No. 4	90 to 100
No. 8	70 to 100
No. 16	50 to 85
No. 30	25 to 65
No. 50	5 to 30
No. 100	0 to 10
No. 200	0 to 4

Table 4  
Joint/Opening Filler Sand  
Grading Requirements

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	100
No. 8	95 to 100
No. 16	70 to 100
No. 30	40 to 75
No. 50	10 to 35
No. 100	2 to 15
No. 200	0 to 10

## 2.05 GEOTEXTILE

- A. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and measured per test methods referenced:
  - 1. Grab Tensile Strength: 200 lbf; ASTM D 4632.
  - 2. Grab Elongation: 12 percent; ASTM D 4632.
  - 3. Trapezoidal Tear Strength: 75 lbf; ASTM D 4533.
  - 4. Puncture Resistance: 90 lbf; ASTM D 4833.
  - 5. Water Flow Rate: 4 gpm per sq. ft; ASTM D 4491.
  - 6. Apparent Opening Size: No. 30; ASTM D 475
  - 7. Permittivity: 0.05 per second, minimum; ASTM D 4491.
  - 8. UV Stability: 70 percent after 500 hours' exposure; ASTM D 4355.
  - 9. Available Product: Propex "Geotex 200ST" or equal.

## 2.06 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Sand: ASTM C 144.
- C. Latex Additive: Acrylic-resin or styrene-butadiene-rubber water emulsion serving as replacement for part or all of gauging water, of type specifically recommended by latex additive manufacturer for use with field-mixed portland mortar bed, and not containing a retarder.
- D. Water: Potable.
- E. Welded Wire Fabric Sheets: Hot-dip galvanized, welded, 12 gauge diameter wire; 2-by-2-inch mesh; comply with ASTM A 123, ASTM A 185 and ASTM A 82 except for minimum wire size.

## 2.07 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturer's written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars when they have reached their initial set.
- B. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with water to a creamy consistency.
- C. For latex-modified portland cement setting-bed mortar, substitute latex admixture for part or all of water per directions of latex-additive manufacturer.
- D. Portland Cement-Lime Setting-Bed Mortar (Thick-set): Type M complying with ASTM C 270, Proportion Specification.
- E. Latex-Modified Portland Cement Slurry Bond Coat: Proportion and mix Portland cement, aggregate, and latex additive for slurry bond coat to comply with directions of latex-additive manufacturer.
- F. Latex-Modified Portland Cement Grout: Add liquid-latex additive to portland cement and sand in proportion and concentration recommended by liquid-latex manufacturer. Proportion cement and sand to comply with written instructions of latex-additive manufacturer.
- G. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10 by weight.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

- C. Remove substances, from concrete substrates, that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- D. Clean concrete substrates to remove dirt, dust, debris, and loose particles.
- E. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.
- F. Clean aggregate base course to remove dirt, dust, debris, and loose particles. Check elevations and slope of the aggregate base course.
- G. Remove substances, protrusions and fins from concrete edge restraints that could impair tight joints.

### **3.02 INSTALLATION, GENERAL**

- A. Do not use pavers with chips, cracks, and voids, which exceed the tolerances listed under Part 2. Do not use pavers outside the approved color range or unit pavers with discolorations and other defects that might be visible or cause staining in finished work.
- B. Pavers shall be clean and free of foreign materials prior to installation. Clean mortar-set pavers of laitance.
- C. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- D. Cut pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Where cutting is required, use the largest size unit possible. Avoid the use of pieces smaller than 1/3 of unit length, or large joint spaces greater than 1/8 inch.
- E. Block splitter may be not used. Hammer cutting is not acceptable.
- F. Joint Pattern: As indicated on Drawings. Path widths to be composed of whole, uncut pavers unless otherwise indicated. Pavers are to be cut to fit at intersections and when abutting walls and thresholds.
- G. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide joint filler and backer rod for sealant-filled joints where indicated. Install joint filler before setting pavers. Sealant materials and installation are specified in Division 32 Section "Concrete Paving."
- H. Provide edge restraints at the perimeter of unit pavers adjacent to landscape areas, and as indicated on Drawings. Install edge restraints before placing unit pavers.
- I. Maintain edges of paver field perpendicular and parallel with the building and other paved surfaces after paver installation and compaction.

### **3.03 AGGREGATE SETTING-BED PAVER APPLICATIONS**

- A. Test compaction of soil subgrade to verify condition at least 95 percent of ASTM D-1557 laboratory density per Division 31 Section "Earth Moving".
- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place and compact aggregate base in thickness indicated on Drawings. Compact by tamping with plate vibrator and screed to depth required to allow setting of pavers per Division 31 Section "Earth Moving".
- D. Test compaction in accordance with Division 31 Section "Earth Moving."

- E. Place sand leveling course and screed to a thickness of 1 inch maximum, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
- F. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- G. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars or lugs, place pavers hand tight against spacer bars/lugs. Use string lines to keep straight lines.
- H. When installation is performed with mechanical equipment, use only unit pavers with spacer bars or lugs on sides of each unit.
- I. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000 ft-lbs compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
- J. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
- K. Before ending each day's work, fully compact installed concrete pavers to within 36 inches of the laying face. Cover pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to protect them from rain.
- L. Mix sand joint stabilizer with sand per manufacturer's printed instructions.
- M. Spread sand and joint stabilizer mixture and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand and joint stabilizer mixture until joints are completely filled, then remove excess material.
- N. Spread pure sand joint stabilizer over surface of pavers and continue compaction.
- O. Sweep to remove excess sand joint stabilizer and completely remove residue by leaf blower.
- P. Gently saturate the surface with water to activate the stabilizer.
- Q. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- R. Repeat joint-filling process 30 days later.

### **3.04 MORTAR SETTING-BED APPLICATIONS**

- S. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- T. Apply cement-paste bond coat over surface of concrete subbase about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch thickness for bond coat.
- U. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch. Cut fabric at expansion joints.
- V. Place mortar bed with reinforcing wire fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated. Cut fabric at expansion joints.
- W. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Cut back, bevel edge, remove, and discard setting-bed material that has reached initial set before placing pavers.
- X. Place pavers before initial set of cement occurs. Immediately before placing pavers on setting bed, apply uniform 1/16-inch-thick, slurry bond coat to bed or to back of each paver with a flat trowel.
- Y. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set and disturb pavers for purposes of realigning finished surfaces or adjusting joints.

- Z. Spaced Joint Widths: 3/8 inch joints, with variations not exceeding plus or minus 1/16 inch.
- AA. Grout joints as soon as possible after initial set of setting bed.
- BB. For ADA pavers with grouted joints, apply paver sealer to the top surface of pavers, avoiding any application of sealer into joints to be grouted. Allow sealer to dry completely before grouting joints.
- CC. Force grout into joints, taking care not to smear grout on adjoining surfaces.
- DD. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
- EE. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- FF. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
- GG. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.

### **3.05 REPAIRING, POINTING, AND CLEANING**

- A. Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units (color, spacing and elevation) as intended at no additional cost to the Owner. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement at no additional cost to the Owner.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
- D. Sweep excess sand from surface of sand set pavers and clean sand from surrounding areas.

**END OF SECTION**

**SECTION 32 30 00  
FILTER CLOTH**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, material, tools, and equipment necessary for furnishing and installing filter cloth in accordance with the Drawings, or as directed by the DEPARTMENT.

**1.03 SUBMITTALS**

- A. Filter cloth material certification and manufacturer's product information.

**PART 2 - PRODUCTS**

**2.01 CLOTH**

- A. Filter cloth shall be composed of plastic yarn fabricated into a pervious sheet with distinct pores or openings.
- B. The plastic yarn shall consist of a long-chain synthetic polymer composed of at least 85% by weight of propylene, ethylene, or vinylidene-chloride and shall contain stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The cloth shall be calendared or otherwise finished so that the yarns will retain their relative position with respect to each other. The edges of the cloth shall be selvaged or otherwise finished to prevent the outer yarn from pulling away from the cloth.
- C. Type A filter cloth, woven or non-woven, shall meet the following requirements:
- |                                     |                         |
|-------------------------------------|-------------------------|
| Grab Tensile Strength (ASTM D 1682) | 90 lbs. min.            |
| Bursting Strength (ASTM D 751)      | 100 psi min.            |
| Equivalent Opening Size (EOS)       | 40 minimum, 100 maximum |
- D. Type B filter cloth, woven or non-woven, shall meet the following requirements:
- |                                     |               |
|-------------------------------------|---------------|
| Grab Tensile Strength (ASTM D 1682) | 200 lbs. min. |
| Bursting Strength (ASTM D 751)      | 500 psi min.  |
- E. Type C filter cloth, woven or non-woven, shall meet the following requirements:
- |                                       |                    |
|---------------------------------------|--------------------|
| Grab Tensile Strength (ASTM D 1682)   | 200 lbs. min.      |
| Grab Tensile Elongation (ASTM D 1682) | 30% maximum        |
| Bursting Strength (ASTM D 751)        | 290 psi min.       |
| Trapezoid Tear Strength (ASTM D 1117) | 50 lbs. min.       |
| Puncture Strength (ASTM D 751)*       | 75 lbs. min.       |
| Water Permeability (AASHTO M 288)**   | 0.001 cm/sec. min. |

\*Using 5/16" flat-tipped pod

\*\*5 cm. Constant head

## 2.02 SEAMS

- A. Seams, when required, shall be sewn with thread of material meeting the chemical requirements given above for plastic yarn. The sheets for filter cloth shall be sewn together at the factory or another approved location to form sections not less than two feet wide. Seams shall be tested in accordance with ASTM D 1682, using one inch square jaws and 12 inches per minute constant rate of traverse. The strengths shall be not less than 90 pounds in any principal direction.

## 2.03 ACCEPTANCE REQUIREMENTS

- A. All brands of plastic filter cloth and all seams to be used will be accepted on the basis of a certification. The CONTRACTOR shall furnish the DEPARTMENT a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the cloth. The mill certificate or affidavit shall attest that the cloth meets the chemical, physical, and manufacturing requirements stated in this Section.

## 2.04 SHIPMENT AND STORAGE

- A. During all periods of shipment and storage, the cloth shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140° F, mud, dirt, dust, and debris. To the extent possible, the cloth shall be wrapped in a heavy-duty protective covering.

## PART 3 - EXECUTION

### 3.01 CONSTRUCTION

- A. Filter cloth shall be placed in the manner and at the locations shown on the Drawings or as directed by the DEPARTMENT. At the time of installation, cloth shall be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage.
- B. The surface upon which the filter cloth is to be placed shall be free of projections or depressions, and rocks, roots, and other sharp objects which may cause the filter cloth to be punctured. The filter cloth shall be placed without stretching and shall lie smoothly in contact with the soil or wall surface. When overlapping of strips is necessary, the joints shall be overlapped a minimum of two feet. End overlaps shall be made in the direction of flow.
- C. The cloth shall be protected at all times during construction from contamination or from damage during its installation or during placement of subsequent covering; contaminated or damaged cloth shall be replaced at the CONTRACTOR's expense, or if the DEPARTMENT permits, torn fabric may be patched. The aggregate material shall be cleaned from the fabric, and the torn area shall be overlain with fabric with a minimum three foot overlap around the edges of the torn area. Care shall be taken that the patch remains in place when material is placed over the affected area.
- D. The WORK shall be scheduled so that not more than 30 Days elapse between the placement of the cloth and the time it is covered with specified material.
- E. Type A filter cloth shall be utilized in all installations except for subgrade reinforcement.
- F. Type C filter cloth shall be utilized for subgrade reinforcement.

- G. Following placement of the fabric on the prepared surface, material of the type shown on the Drawings shall be back-dumped on the previously spread fabric or ground adjacent to the fabric and carefully pushed or spread onto the fabric by a dozer or other machinery. A minimum depth of one foot, or the depth shown on the Drawings, shall be maintained at all times between the fabric and the wheels or tracks of the construction equipment. At no time shall equipment operate on the unprotected fabric. The material shall be spread in the direction of the fabric overlap. Special care shall be taken to maintain a proper overlap and fabric continuity.

**END OF SECTION**

**SECTION 32 30 02  
PAINTED TRAFFIC MARKINGS**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and placing painted traffic markings as shown on the Drawings.
- B. Details not shown on the Drawings shall be in conformity with the latest edition of the Manual of Uniform Traffic Control Devices (MUTCD) and the Alaska Traffic Manual Supplement published by the Alaska Department of Transportation and Public Facilities.
- C. This WORK shall also include re-striping all existing paint markings to their original or better conditions if damaged by the CONTRACTOR's operations.

**PART 2 – PRODUCTS**

**2.01 MATERIAL**

- A. Paint for traffic markings shall use one of the following:
  - 1. AASHTO M 248, Type F (Alkyd Resin), or
  - 2. FSS TT-P-19D(1) Paint, Latex (Acrylic Emulsion, Exterior), or
  - 3. The current State of Alaska DOT&PF maintenance specification for pavement marking paint.
- B. Paint for concrete shall meet FSS TT-P-19D(1) Paint, Latex (Acrylic Emulsion, Exterior).

**PART 3 – EXECUTION**

**3.01 GENERAL**

- A. Lines shall be applied as solid, dashed or dotted stripes, either singly or in combination, as shown on the Drawings. Dashed lines shall be applied in a 40 foot cycle consisting of a ten foot dash and a 30 foot gap between dashes, unless otherwise shown on the Drawings. The CONTRACTOR shall use an accurate dashing mechanism, which is capable of being easily adjusted to retrace existing dashed markings or to apply new materials at the correct spacing. Dashed lines which are to be applied over plainly visible existing dashed lines shall begin within six inches of the beginning of the existing dash, unless otherwise directed by the DEPARTMENT.
- B. Gaps not marked as a result of template use for spray-applied auxiliary markings shall be filled with marking material after template removal.
- C. Pavement markings shall be free of uneven edges, overspray, or other readily visible defects which detract from the appearance or function of the pavement markings.

- D. Lines shall be sharp, well defined, and uniformly retroreflective. The width of the applied paint shall be the width specified plus or minus ¼-inch. Fuzzy lines, excessive overspray, or non-uniform applications are unacceptable. Lines shall be inspected at night by the DEPARTMENT to verify effective light reflection. Pavement markings which are improperly applied, located, or reflectorized shall be corrected. Lines applied with insufficient material quantities shall be properly reapplied. Improperly located lines shall be removed. New lines shall then be applied in the correct locations at the CONTRACTOR's expense, including the furnishing of approved materials.
- E. Methods and equipment used for pavement preparation and marking removal shall be subject to the approval of the DEPARTMENT.
- F. Other construction WORK, such as shoulder paving, topsoil placement and grading, and seeding, shall be scheduled and performed in a manner to avoid damage to applied pavement markings.
- G. Pavement marking materials shall not be applied to the reflector of a recessed pavement marker. The CONTRACTOR shall interrupt the application of the pavement marking line at each recessed pavement marker where marking material would otherwise be applied to the marker prismatic reflector. The maximum gap in the marked line at each marker shall be 18-inches. Pavement marking material applied to a prismatic reflector surface shall be removed by the CONTRACTOR, or the reflector shall be replaced at his expense the same working day. When the CONTRACTOR must remove material from the reflector, the reflector's brightness shall be restored to its prior condition.

### **3.02 PAVEMENT PREPARATION**

- A. The CONTRACTOR shall clean all visible loose or foreign material from the surface to be marked. The pavement marking equipment shall be equipped with an air jet to remove all debris from the pavement in advance of the applicator gun. The air jet shall operate when marking material is being applied and be synchronized with marking material application.
- B. Pavement markings shall be applied only when the surface is clean and dry. The CONTRACTOR shall power broom clean all surfaces where edge lines are to be applied. When required by the DEPARTMENT, other surfaces shall also be power broom cleaned.
- C. Marking shall not be applied to Portland cement concrete until the concrete in the areas to be marked is clean of membrane curing material and is dry.

### **3.03 LAYOUT AND PREMARKING**

- A. The CONTRACTOR shall lay out the locations of all lines, words and other symbols to ensure their proper placement. The layout and premarking lines shall be approved by the DEPARTMENT before marking operations are started. When applying longitudinal or transverse lines, the CONTRACTOR shall use existing lines, construction joints or premarking to guide this marking equipment.
- B. Premarking shall be located from survey data or reference points and offset so as to parallel the theoretical edge of the marking lines at a maximum distance of one inch. Templates are required for the layout of arrows, words and other symbols. Premarking for longitudinal lines shall be placed at 40-foot intervals, and shall not exceed two inches in width or 12 inches in length. Premarking for auxiliary markings shall be located as shown on the Drawings or schematic forms provided by the DEPARTMENT.

### **3.04 LINE PLACEMENT TOLERANCE**

- A. Pavement marking lines shall be straight or smoothly curved, true to the alignment of the pavement, and shall not deviate laterally from the proper location at a rate of more than two inches in 100 feet. No deviation greater than three inches will be permitted.

### **3.05 LINE TYPES**

- A. Marking materials shall be applied at a minimum rate of 16.5 gallons per mile per four inch wide stripe, with a 20 mill minimum thickness, and shall, except for parking lot stall markings, be uniformly retroreflective. The minimum rate of application for broken traffic stripes shall be prorated.
- B. Edge lines shall be continuous stripes, four inches in width. Center of stripe shall be located as shown on the Drawings.
- C. Lane lines shall be four inch wide white stripes between contiguous lanes of pavement carrying traffic in the same direction. They shall be dashed unless specified solid. They shall be offset to the left of the longitudinal joint, if present, or the theoretical line lying between contiguous lanes, if a joint is not present. The nearer edge of the stripe shall be two inches to the left of the joint or line.
- D. Centerlines shall be single or double yellow stripes between contiguous lanes of pavement carrying traffic in opposite directions. Centerline marking shall also include two way left-turn lane striping and the outline of left-turn island. Each stripe shall be four inches wide, solid or dashed.
- E. Channelizing lines shall be continuous white stripes, eight inches wide.
- F. Stop lines shall be solid white strips, 24-inches wide. Crosswalk lines shall be solid white strips, 24 inches wide.
- G. Parking lot stall marking lines shall be continuous white stripes, four inches in width.
- H. Lane arrows and letters shall be white markings, with a minimum rate of application of 0.01 gallon per square foot of markings.

### **3.06 EQUIPMENT AND APPLICATION OF PAINTED TRAFFIC MARKINGS**

- A. The markings shall be applied by machine methods acceptable to the DEPARTMENT. The paint machine shall be of the spray type capable of satisfactorily applying the paint under pressure with uniformity of feed through nozzles spraying directly upon the pavement. Each machine shall be capable of applying two separate stripes, either solid or skip, at the same time. Each paint tank shall be equipped with a mechanical agitator. Each nozzle shall be equipped with satisfactory cutoff valves which will apply broken or skip lines automatically. Each nozzle shall have a mechanical bead dispenser that will operate simultaneously with the spray nozzle and distribute the beads in a uniform pattern at the rate specified. Each nozzle shall also be equipped with suitable line guides consisting of metallic shrouds or air blasts.
- B. The paint shall be thoroughly mixed prior to application, and shall be applied when the air temperature is above 40° F and rising, to a clean and dry surface
- C. The painted area shall be protected from traffic until the paint is thoroughly dry.

**3.07 REMOVAL OF PAVEMENT MARKINGS**

- A. When indicated on the Drawings, pavement markings shall be removed. The markings shall be removed by high-pressure water blast, sand blast, high temperature burning with excess oxygen, or other methods, with the approval of the DEPARTMENT. Care shall be exercised during marking removal not to scar, discolor or otherwise damage the pavement surface. Overpainting or other methods of covering markings in lieu of removal shall not be permitted.

**END OF SECTION**

**SECTION 32 32 15**  
**STONE BLOCK RETAINING WALLS**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This Section includes dry stack stone retaining walls on graded aggregate base includes providing all labor, materials, tools and equipment necessary for furnishing and installing stone block retaining walls in conformance with the Drawings and Specifications. Placement is decorative and artistic rather than to function primarily in a retaining capacity
- B. Related Documents include the following:
  - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this section.

**1.02 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Provide stone slabs or cut stone slabs that when placed or overlaid are capable of withstanding the effects of gravity loads due to soil pressures resulting from grades indicated.
  - 1. Include the effects of sloped backfill as indicated on Drawings.

**1.03 SUBMITTALS**

- A. Samples for Verification: Photographs of each color and texture of stone. Photographs shall also include accurate dimensional references.
- B. Qualification Data: For Installer.

**1.04 QUALITY ASSURANCE**

- A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects.
  - 1. Build mockups of two adjacent stone units as shown on Drawings.
    - a. Include backfill to typical finished grades at both sides of wall.
    - b. Include appropriate positioning to align the stones to minimize protruding edges into the unit paver areas.
  - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. Installer Qualifications: 10-years of successful and satisfied projects and owners experience setting large monolithic stone blocks and fabricating by machine or hand stone faces.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Store and handle stone to prevent deterioration or damage due to moisture, temperature changes, contaminants, breaking, chipping, or other causes.
- B. Do not place or lift stones directly with forklift or steel chains.

**PART 2 - PRODUCTS**

**2.01 STONE**

- A. Commercially available local Alaska granites or metamorphic stone free of cracks, seams, or imperfections which would impair the structural integrity of the material, Design intent is to select stone which matches as closely as practicable the stone indigenous to the Project site.
  - 1. Available from: Stablers Point Quarry, Juneau AK. or equal.
  - 2. Stone Setters: Guinett Masonry, PO Box 70040, Vancouver, WA 98665, Telephone: 360-695-2988, Or equal.

3. Sizes: As indicated on the Drawings.
4. Color: As naturally occurring.

## **2.02 INSTALLATION MATERIALS**

- A. Leveling Base: Comply with requirements in Division 31 Section "Base Course" for base material.
- B. Nonreinforced Soil Fill (Amended Topsoil): Comply with requirements in Division 32 Section "Soil Preparation" for satisfactory soils.
- C. Filter Fabric: Comply with requirements in Division 32 Section "Filter Cloth."

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of free standing stone units
  1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Notify the DEPARTMENT for on-site quarry inspection of stone prior to delivering to the project site. Provide 3 days notice of stone selection visit at the quarry.

### **3.02 STONE INSTALLATION**

- A. Notify the DEPARTMENT for on-site inspection and observation during the stone setting proces. Provide 3 days notice of stone setting schedule.
- B. General: Place stone in reasonably straight lines as indicated on the Drawings. Any overlaid stone shall be completely stable, no tipping or wobble permitted.
- C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.
- D. Stone Course: Place single course of stone blocks on leveling base/course for full length of wall. Place units in firm contact with each other, properly aligned, and with a battered side facing outward.
  1. Place and compact fill, either drainage or soil fill as indicated, to top of stone course. Place fill on both sides of wall at same time without disturbing alignment of units. Fill voids between and within units from back side with quarry spalls, tightly packed.

### **3.03 FILL PLACEMENT**

- A. General: Comply with requirements in Division 31 Section "Base Course."
- B. Place, spread, and compact fill in uniform lifts for full width and length of stone elements as wall is laid. Begin at back of wall and place and spread fill toward paver edge or second row of stone.
  1. Compact drainage fill to not less than 90 percent maximum dry density according to ASTM D 1557.
  2. Compact soil fill to not less than 90 percent maximum dry density according to ASTM D 1557.
    - a. In areas where only hand-operated compaction equipment is allowed, compact to not less than 85 percent maximum dry density according to ASTM D 1557.
  3. Compact nonreinforced soil (Amended Topsoil) fills to comply with Division 32 Section "Soil Preparation."

### **3.04 CONSTRUCTION TOLERANCES**

- A. Variation from Level: For bed-joint lines along walls, do not exceed 12 inches in 10 feet. Exceptions for face tilt for artistic effect are appropriate reasons for variation from level.
- B. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 6 inches in 10 feet.

**3.05 ADJUSTING AND CLEANING**

- A. Replace units so stone gravity retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

**END OF SECTION 32 32 15**

## SECTION 32 8420

### PLANTING IRRIGATION GENERAL

#### 1.01 WORK INCLUDES

- A. This Section includes piping, specialties for manual control irrigation system.
- B. Related sections drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this section.
- C. DEFINITIONS  
Mainline: Piping downstream from irrigation point of connection to valves. Piping is under constant pressure.
- D. The following are industry abbreviations for plastic materials:
  - 1. PE: Polyethylene plastic.
  - 2. PVC: Polyvinyl chloride plastic.
  - 3. TFE: Tetrafluoroethylene plastic.

#### 1.02 SITE CONDITIONS

- A. Meet with DEPARTMENTDEPARTMENT DEPARTMENT on site to review scope of work.

#### 1.03 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties, unless otherwise indicated:
  - 1. Irrigation Main Piping: 250 psi.
  - 2. Quick Coupler Piping: 250 psi.
  - 3. Drain Line Piping: 200 psi.

#### 1.04 SUBMITTALS

- A. Shop Drawings: Submit design-build irrigation plan for approval by DEPARTMENTDEPARTMENT prior to construction. Show the following information on the drawing:
  - 1. Irrigation system piping, including plan layout, and locations, types, sizes, capacities, and flow characteristics of irrigation system piping components.
  - 2. Static water pressure and flow in gallons per minute at available source.
  - 3. Piping layout to water sources. Coordinate to provide required water services.
  - 4. Water meters, backflow preventers, valves, piping, and devices.
  - 5. Location of sleeves under pavement,
  - 6. Plant and landscaping features, and site structures, including sculpture pieces.
  - 7. Schedule of equipment to be used.
  - 8. Areas of sprinkler spray and overspray.
  - 9. The irrigation system shall be gravity drainable and have drain valves to facilitate gravity drainage.
  - 10. See Drawings for irrigation installation details.
- B. Materials List: Within 30 days after award of Contract, and before any irrigation system materials are delivered to the job site, submit to the DEPARTMENT's Representative a complete list of all irrigation system materials proposed to be furnished and installed. Submit catalog data, including manufacturer's name and catalog number, model number, specifications, brochures, or other data giving complete information about each item. Include pressure ratings, rated capacities, and settings of selected models for the following:
  - 1. Backflow Prevention Devices
  - 2. General-duty valves.
  - 3. Specialty valves.

4. Irrigation specialties.
- C. Record Drawings: Provide Record Drawings illustrating actual as-built locations for all irrigation equipment per Division 01 Section "Closeout Submittals."
  1. During the course of installation, carefully show in red line on a print of the irrigation system Drawings, all changes made to the irrigation system during installation. This drawing to be labeled "Record Copy". Make available for inspection. Do not use for construction.
  2. Upon completion of the work, transfer all changes to a complete set of the construction drawings. Changes to work drawn to be cleanly erased and new work professionally drafted in proper locations. Dimension and note clearly all underground work located horizontally and vertically. Clearly mark each sheet with the words "As-Built" and date.
  3. Submit As-Built Drawings for approval. If Drawings are not clear, or information is not complete, revise and resubmit for approval. Project will not be complete until As-Built Drawings are submitted and accepted by DEPARTMENT's Representative.
  4. Submit As-Built Digital Drawings after hard-copy drawings are approved. Digital drawings shall be in Auto CAD release 2010 format or newer and copied onto a compact disk. Submit at time of final examination for irrigation system.
- D. Tools: Submit to the DEPARTMENT two sets each, as appropriate, of controller keys, quick coupler operating keys with hose swivels, gate valve keys, air compressor valve keys, valve box keys, and unique tools or devices needed to access, operate, adjust or maintain the system. Submit at time of final examination for irrigation system.
- E. DEPARTMENT Guide Manuals: Submit operating and maintenance guides for the entire system and for each piece of equipment in the system. Instructions for system winterization are to be included. Submit to the DEPARTMENT's Representative at the time of the final examination of irrigation system.
- F. Testing Certificates:
  1. Certification of backflow devices.
  2. Hydrostatic pressure testing.

#### **1.05 QUALITY ASSURANCE**

- A. Provide at least one person who shall be present at all times during execution of this portion of the Work, and who is thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation, and who shall direct all work performed under this Section.
- B. Except where more stringent requirements are specified, conform to the "Uniform Plumbing Code" as adopted and modified by the State of Alaska and all legally constituted authorities having jurisdiction. If more restrictive than those specified herein, notify the DEPARTMENT's Representative prior to starting work.
- C. All materials and equipment in the system to be new and be brands and types as shown in the Drawings or as specified herein, or as accepted by the DEPARTMENT's Representative.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store materials in areas designated by the DEPARTMENT.
- C. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
- D. Use all means necessary to protect irrigation system materials from damage, theft and vandalism before, during, and after installation.
- E. In the event of damage, immediately make all repairs and replacements necessary to the satisfaction of the DEPARTMENT's Representative, and at no additional cost to the DEPARTMENT.

### 1.07 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by DEPARTMENT or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
  - 1. Notify DEPARTMENT no fewer than three days in advance of proposed interruption of water service.
  - 2. Do not proceed with interruption of water service without written permission of the DEPARTMENT.
- B. Locate and identify, with visible marking, existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during excavation operations.
- C. Should uncharted piping or other utilities be encountered during excavation, consult the utility DEPARTMENT immediately for directions. Cooperate with the DEPARTMENT and public and private utility companies in keeping their respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility DEPARTMENT. The cost of repairing charted utilities shall be paid by the Contractor at no additional cost to the DEPARTMENT.
- D. Protect buildings, equipment, utilities, sidewalks, paving, reference points, monuments, and markers on the site. Take extreme caution when trenching at or adjacent to aggregate base courses, sand-set unit pavers and around existing trees and their root systems. No root cutting is allowed without prior approval. Protect adjacent properties. Protect work by others. Replace or repair damaged items at no cost to the DEPARTMENT and to the approval of the DEPARTMENT's Representative.
- E. Coordinate with other trades affecting or affected by Work of this Section.

### 1.08 WARRANTY

- A. Warranty work and materials in writing for one year from the date of Final Acceptance, against defective workmanship and materials. All failures in workmanship or materials will be repaired at no additional cost to the DEPARTMENT immediately after notification by the DEPARTMENT's Representative.
- B. Contractor shall be responsible for maintaining system and protecting it from all damage until date of Final Acceptance at no additional cost to DEPARTMENT. This shall include damage caused by vandalism or adverse weather conditions.

### 1.09 ONE-YEAR CORRECTION PERIOD

- A. Repair any settling of backfilled trenches occurring during the one-year correction period at no additional cost to DEPARTMENT. Include complete restoration of all damaged planting, pavement, and other improvements of any kind.

### 1.10 SYSTEM FAMILIARIZATION

- A. Upon acceptance of the system by DEPARTMENT's Representative, Contractor shall provide the necessary keys and other tools necessary to operate, drain, and activate the system. Contractor shall train DEPARTMENT's maintenance personnel and provide written instructions to ensure that the system operation, maintenance, and winterizing can continue after departure of the Contractor. Contractor will be liable for all damages or losses resulting from failure to comply with the provisions of this Article.

## PART 2 - PRODUCTS

### 2.01 PIPES, TUBES AND FITTINGS

- A. Steel Pipe: ASTM A-53, Schedule 40, Type S or E, Grade A or B, galvanized with threaded ends.

1. Steel Pipe Nipples: ASTM A-733, made of ASTM A-53 or ASTM A-106, Schedule 40, galvanized, seamless steel pipe with threaded ends.
  2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
  3. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
  4. Cast-Iron Flanges: ASME B16.1, Class 125.
  5. Cast-Iron Flanged Fittings: ASME B16.1, Class 125, galvanized.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- C. Brass Pipe: ASTM B584 Alloy C84400 Standard Specifications for copper alloy sand casting for general applications.;
1. Brass Pipe Nipples: ASTM B-43, seamless red brass pipe with threaded ends.
  2. Brass Pipe Fittings: ANSI B-16.15 cast copper alloy threaded fittings.
  3. Brass Unions: ANSI B-16.15, Federal Specification WW-U-516 for Type III, Class A and Class B cast copper alloy threaded unions.
- D. PVC Pipe, General:
1. Material used in the manufacture of the pipe shall be domestically produced rigid PVC 1120 compound, Type I Grade I, with Cell Classification of 12454 as defined in ASTM D-1784.
  2. Pipe shall continuously bear the National Sanitation Foundation seal of approval for potable water usage and comply with the following requirements for product marking ASTM D-2241, D-1785 and D-2665 as applicable. Markings shall include: manufacturers name; nominal pipe size; outside diameter system; material designation code; applicable thermoplastic pipe Standard Dimension Ratio designation code (SDR number) or pipe schedule, and corresponding pressure rating in psi for water at 73 degrees Fahrenheit.
  3. Belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D-2672.
  4. Pipe sizes 1/2 inch and 1-1/4 inch are not allowed.
- E. PVC Mainline (Buried 24 inches below grade): ASTM D-1785, Schedule 40
- F. PVC Mainline (Buried less than 24-inch below grade and below pedestal paver systems): ASTM D-1785, Schedule 80.
- G. PVC Lateral Line, Pressure-Rated Pipe: ASTM D-2241, SDR 21, 200 psi minimum.
- H. PVC Nipples and Fittings:
1. PVC Socket Fittings, Schedule 40: ASTM D-2466; and Schedule 80: ASTM D 2467.
  2. PVC Pipe Nipples: ASTM D-1785, PVC 1120 compound, Schedule 80.
  3. PVC Threaded Fittings, Schedule 80: ASTM D-2464.
- I. Sleeves: PVC pipe under all paving, sized to accommodate required sizes and numbers of pipes and wires, 6-inch minimum diameter, in no case less than twice the diameter of the pipe being sleeved.
1. Schedule 40 PVC, ASTM D-1785 or Plastic Sewer Pipe ASTM D-3034, SDR-35, PVC conforming to ASTM D-1784, N.S.F. approved pipe.

## 2.02 JOINING MATERIALS

- A. Copper Pipe Solder:
1. Silver solder, 45 percent silver, 15 percent copper, 16 percent, zinc, 24 percent cadmium and solidus at 1125 degrees Fahrenheit, and liquids at 1145 degrees Fahrenheit; conforming to ASTM B206-52T and Federal Specification QQB 00655.

- B. Pipe Solvent Cement:
  - 1. PVC Solvent Cement ASTM D-2564.
  - 2. 'Weld-On' I.P.S. 705 for pipe sizes up to 2 inch diameter.
  - 3. 'Weld-On' I.P.S. 711 cement with P70 primer for pipe sizes 2-1/2 inches and larger.
- C. PVC Primer:
  - 1. ASTM F-656, 'Weld-On' I.P.S. P-70.
- D. PVC Cleaner:
  - 1. SCAQMD 1168, Low V.O.C, 'Weld-On' I.P.S. C-65
- E. Field-Assembled Swing Joints:
  - 1. For Quick Couplers: Schedule 40 PVC fittings and Schedule 80 PVC nipples as shown on the Drawings. Size to match inlet size of rotor head or quick coupler. Use is acceptable for all flows.

### 2.03 GENERAL-DUTY VALVES

- A. Manufacturers:
  - 1. Apollo: Product Isolation Valve 70 Series.
  - 2. Nibco: Product, Brass Gate Valve, T-113.
  - 3. Champion: Product, Remote Control Isolation Valve, 300RS, valve size.
  - 4. Nibco: Product, Drain Valve, T-311-Y.
- B. Isolation Valve: Full port ball valve with threaded ends, minimum 400 PSI CWP rating, forged brass and cast bronze bodies and end pieces RPTFE seats and seals, blow-out proof stem design, chrome-plated brass ball, with stainless steel handle. Size same as pipe on which it is installed.
- C. Gate Valve: Brass body construction, full-port, with threaded ends, non-rising stem, 150 psi. Size same as pipe on which it is installed.
- D. Drain Valves (Mainline Drain Valves): bronze, angle-pattern, globe valve with screw-in bonnet, integral seat, 200 PSI CWP rating, conforming to MSS SP-80, 1 inch minimum. Angle-pattern for on-grade installations.

### 2.04 SPECIALTY VALVES

- A. Manufacturers:
  - 1. RainBird: Product, Quick Coupling Valve, As indicated on DRAWINGS
- B. Quick Coupling Valve: 3/4-inch double-track, key lug, locking, locking rubber cover, two-piece body, with corresponding key and swivel hose ell.

### 2.05 VALVE BOXES And VAULTS

- A. Manufacturers:
  - 1. 'Carson Brooks', 'Pentek', 'RainBird' or equal: Product, Plastic Valve Boxes.
  - 2. 'Utility Vault Company', 'Synertech', 'Oldcastle Precast' or equal: Product, Polymer Concrete Vaults.
- B. Valve Boxes: HDPE plastic boxes with locking top and 6-inch extensions to facilitate required depth of installation where applicable. Lids shall be black color unless otherwise noted.
  - 1. Isolation valves shall be installed in standard boxes.
  - 2. Quick couplers shall be installed in 10-inch round valve boxes.
  - 3. Drain valves shall be installed in 5-1/4 inches round adjustable valve boxes.
- C. Valve Box and Vault Accessories:
  - 1. Drain Rock: 3/4 inch to 1/4 inch clean and washed pea gravel, no fines.
  - 2. Filter Fabric: Woven or non-woven geotextile for use in separating drain rock from subgrade in valve box and vault installations while providing adequate drainage.

3. Brick or Concrete Block Supports: (2)-4-inch by 8-inch by 4-inch bricks or (1) 8-inch by 8-inch by 4-inch concrete paver at each corner of valve box.

## **2.06 OTHER MATERIAL**

- A. Manufacturers:
  1. Terra Tape: Product, Detectable Warning Tape, or equal.
  2. Christy (T. Christy Enterprises): Product, Valve Identification Tags or equal.
  3. 3M: Product, Control Wire Numbering Labels, or equal.
- B. Identification Markers:
  1. Detectable Warning Tape: Minimum 3-inch wide, 5 mils thick inert plastic tape with continuous layer of aluminum foil encased in the plastic. Tape identification shall match the utility being marked on all mainline.
- C. Concrete for Thrust Blocking: All concrete for thrust blocks shall achieve minimum strength of 3000 psi at 28 days.
- D. Quick Coupler Stabilizing Wing: Polyester-coated ductile-iron, with stainless steel bolt; Leemco or equal.
- E. Drainage Backfill: Cleaned gravel or crushed stone, open graded from 4 inch maximum to 1/4 inch minimum.
- F. Sand: Clean, suitable for backfilling and bedding pipe.
- G. All other materials not specifically described but required for a complete and proper irrigation system installation shall be new, first quality of their respective kinds, and subject to approval.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Prior to all work of this Section, carefully examine the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- C. In the event of discrepancy, immediately notify the DEPARTMENT's Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved. Start of work denotes acceptance.
- D. Install materials and equipment in strict accordance with manufacturer's written specifications and recommendations and all applicable codes.
- E. Provide protection at all times to keep rock, dirt, gravel, debris, and all other foreign materials from entering piping, valves, and other irrigation equipment.

### **3.02 LAYOUT**

- A. Make all necessary measurements in the field to ensure precise fit of items in accordance with the approved Shop Drawings.
- B. Layout to follow as closely as practicable the design as shown on the Drawings. Use field marking paint to stake out mainline routing and locations of all proposed equipment, for acceptance by DEPARTMENT's Representative, prior to trenching.
- C. Full and complete coverage without overthrow onto roadways, sidewalks or buildings is required unless otherwise accepted by DEPARTMENT's Representative.
- D. Systems shall meet minimum pressure at last head in each zone as shown on approved Shop Drawings. Notify DEPARTMENT's Representative immediately if any modification of piping

layout will be required to accomplish this. Do not proceed until layout has been verified in the field with the DEPARTMENT's Representative.

- E. Follow pipe layout plan making modifications as necessary to avoid trenching through roots of existing trees or other obstructions. Take care in protecting all existing tree root zones.
- F. Locate valves/valve boxes in planting beds, (not in lawn areas). Locate mainline 24 inches from the edge of paving, or in lawn areas 24 inches from the edge of the adjacent planting bed. Avoid locating valves at low points and in swales to avoid flooding of valve boxes.

### 3.03 WATER SOURCE

- A. Connect system as indicated on the approved Shop Drawings. Make arrangements with the DEPARTMENT for water shut-off, if necessary.

### 3.04 TRENCHING

- A. Refer to Division 31 Section "Earth Moving" for excavating and trenching.
- B. Locate existing utilities. Trench along routes as indicated on approved Shop Drawings.
- C. Trenches to be straight and true or conform to adjacent curved edges, with bottom uniformly sloped at a minimum 1 percent.
- D. Provide minimum cover over top of underground piping according to the following:
  - 1. Irrigation Mainline Piping: Minimum depth of 24 inches below finished grade.
  - 2. Lateral Line Piping: 18 inches.
  - 3. Drain Piping: 18 inches.
  - 4. Sleeves: 24 inches under paving; 36 inches under roads.
- E. Keep trenches free of pipe-damaging rocks and debris.
- F. Trench to be 12 inches wide minimum and wide enough to allow all pipes to lie side by side with 6-inch minimum separation between pipes.
- G. Install warning tape directly above pressure piping, 12 inches below finished grades, except 6 inches below subgrade under pavement and slabs.

### 3.05 PIPE

- A. Do not use solvent cement on threaded joints. Wrap joints with minimum three wraps of Teflon tape.
- B. Ensure that the inside of the pipe remains absolutely clean. Pipe ends shall be protected and not left open. Remove all foreign matter and dirt from inside of pipe before lowering into trench.
- C. Lay pipe in accordance with standard practices, on solid foundation, uniformly sloped, substantially supported at all locations. "Snake" pipe slightly from side to side in trench to allow for expansion and contraction. Keep pipe markings visible.
- D. PVC pipe joints to be solvent welded except as indicated on the Drawings. Cut pipes square, deburr, wipe from surface all saw chips, dust, dirt, moisture and all foreign matter which may contaminate the cemented joint. Clean pipe with pipe cleaner to remove dirt, oil and grease. Apply primer and solvent cement. Make joints in accordance with manufacturer's recommendations.
- E. For 90-degree turns in mainline pipe, install two 45-degree fittings.
- F. For non-standard angles and bends, install double fittings to avoid stressing the pipe or fittings.
- G. Underground lines shall have a minimum horizontal and vertical clearance of 12 inches from other utility lines. For lines crossing at angles from 45 degrees to 90 degrees with each other, maintain 6-inch vertical clearance. No line shall be installed parallel to and directly over another line.

- H. Provide 6 inches clearance between pipes. Do not stack pipe unless accepted by DEPARTMENT's Representative to avoid tree roots.
- I. Do no solvent welding of pipe when raining or when temperature is below 40 degrees Fahrenheit.
- J. No fittings are to be closer than 6 inches apart.
- K. Obtain tight, inseparable joints. Allow 24-hour curing before testing.
- L. Install concrete thrust blocks at all changes of direction for mainline pipe 2-1/2 inch or greater in diameter. Place a minimum of 1 cubic foot of fully mixed concrete against the pipe and firm undisturbed soil in accordance with the pipe manufacturer's recommendations.
- M. Provide pipe insulation on mainline and lateral line pipe on-structure having less than 18 inches of cover. Provide insulation sealing tape continuously along seam of pipe insulation.

### 3.06 IRRIGATION SLEEVES

- A. Install piping and wiring in sleeves under sidewalks, roadways, parking lots, and railroads.
  - 1. Install piping sleeves by boring or jacking under existing paving if possible.
- B. Install separate sleeves for irrigation lines and control wires under pavement prior to placing pavement materials wherever possible.
- C. Extend sleeves beyond pavement edge a minimum of 12 inches. Install sleeves with minimum 24 inches depth of cover to the top of the pipe.
- D. If length of required sleeve is greater than the length of the unit of pipe, solvent weld joints. Otherwise all sleeves shall be of one continuous length of pipe.
- E. Tape ends of sleeve closed to keep soil out of the sleeve until irrigation lines and control wire are installed.
- F. Permanently attach a single length of 14 gauge trace wire above the entire length of the sleeve.
- G. Stake both ends of sleeves with a readily visible stake extending 12 inches above-grade and below-grade to the bottom of the sleeve. Mark the above-grade portion of the stake with the words "Irrig. Sleeve". Remove stakes after sleeves are recorded on As-Built Drawings and after irrigation lines and control wires are installed and accepted by DEPARTMENT's Representative.
- H. General:
  - 1. Install valve boxes plumb to grade in a neat and uniform pattern per manufacturer's directions, and as shown on the Drawings.
  - 2. Install valve with 3 inch of clearance between top of valve and underside of valve box cover.
  - 3. Install 1 cubic foot of drain rock in the bottom of all valve boxes.
  - 4. Provide 1-inch clearance between bottom of valve assembly and top of drain rock.
  - 5. Thoroughly flush supply lines before installing valves.
- I. Drain Valves:
  - 1. Install manual drain valves at low points along mainline to ensure complete gravity drainage of all mainlines. More drain valves may be required than are shown on approved Shop Drawings. Provide required number of drain valves at no additional cost to the DEPARTMENT.
  - 2. Install one drain valve in point of connection vault immediately downstream of backflow preventer.
  - 3. Pipe drain valves into approved drainage structures. Install drain piping with minimum of 18 inches of cover to top of pipe.
  - 4. Drain Pockets: Where no drainage structures exist, excavate 1/3 cubic yard of soil material at discharge to drain valves. Backfill with drainage backfill to 12 inches below grade. Wrap drainage backfill with drainage fabric and backfill remainder with amended topsoil.

- J. Quick Coupling Valves:
  - 1. Provide schedule 80 PVC threaded nipples and fittings at quick coupler and ball valves.
  - 2. Install quick coupler valves at 100-feet on center along all mainline and one at the point-of-connection and at each trash enclosure.
  - 3. Stabilize quick coupler nipple with one 24-inch number 4 rebar stake or quick coupler stabilizing wing. Attach stake to nipple with two 1/2-inch stainless steel worm drive hose clamps.
- K. Isolation Valves: Install isolation valves along mainline at all points-of-connection and upstream of all road crossings. Install plumb to grade in a neat and uniform pattern as per manufacturer's directions, and as shown on Drawings.

### **3.07 FLUSHING**

- A. Flush lines with water for a minimum of 5 minutes each zone prior to installation of irrigation valves.
- B. Cap risers immediately after flushing.

### **3.08 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Where there is more than one controller on the Project, install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
- B. Install valve identification tags on each automatic control valve per manufacturer's recommendations.
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tape over underground piping, during backfilling of trenches.

### **3.09 TRACE WIRE**

- A. Place one strand of trace wire for all mainlines, and leave end at point of connection location. Tape wire to top of mainline at no less than 36-inch intervals. All locator wire shall be spliced together with water-tight splice connectors.
- B. Run a 12-inch loop of trace wire into each remote control valve box for ease of detection.

### **3.10 PRESSURE TESTING**

- A. Notify the DEPARTMENT's Representative five days before pressure testing.
- B. Backfill trenches sufficiently to ensure the stability of pipe, leaving joints exposed.
- C. Mainline and lateral lines may be tested at different times to allow isolation of either
- D. Supply certified pressure gauge and force pump during tests.
- E. Mainline Testing:
  - 1. Thoroughly flush piping before testing. Cap all fittings on mainline fill with water.
  - 2. Test mainlines to control valves at 100 psi for 1 hour. If pressure loss occurs, inspect the entire system, make water-tight, and retest until no pressure loss occurs for the testing period.
  - 3. Pressure test must show no pressure loss for the specified period and be accepted by the DEPARTMENT's Representative before backfill of trenches will be allowed.

### **3.11 BACKFILLING**

- A. Delay backfilling until piping is pressure tested and accepted.
- B. Place clean sand or approved backfill 3 inches below and 6 inches above all pipe. Fill the rest of the trench with approved material, free of rocks and debris capable of damaging pipe. Compact to adjacent soil density in 6 inches lifts.
- C. Stones larger than 1-inch diameter are not allowed in backfill material.

- D. Place metallic locating tape in all mainline trenches in accordance with manufacturer's instructions.
- E. Fill mainline with water at approximately 25 psi during backfilling operations.

### **3.12 FIELD QUALITY CONTROL**

1. Furnish all materials and perform all work required to correct any inadequacies, to the complete satisfaction of the DEPARTMENT's Representative. This shall include any changes affecting coverage due to any deviation from plans.
2. A Field Observation Report shall be generated by the DEPARTMENT's Representative. This report shall serve as an Item/Action notification which may require the contractor to make changes and repairs as noted therein.
3. One return site observation shall be provided by the DEPARTMENT's Representative to determine whether the items listed in the first site observation report have been corrected. After making the corrections noted in the Field Observation Report, notify the DEPARTMENT's Representative at least 48 hours in advance, and perform another coverage test in the presence of the DEPARTMENT's Representative for approval.
4. Any item listed in the Field Observation Report requiring action that is not considered to be a part of the original contract, must immediately be brought to the attention of the DEPARTMENT. This shall be the responsibility of the contractor and must be done in a manner as to enable the contractor to correct the item prior to the next field observation.
5. Upon completion of each phase of work, the entire system shall be tested and adjusted to meet site specifications.

### **3.13 STARTUP SERVICE**

- A. Verify that components are installed and connected according to the Contract Documents and are functioning properly.
- B. Complete startup checks according to manufacturer's written instructions.

### **3.14 CLEANUP**

- A. Remove debris from project site upon completion or sooner, if directed.

### **3.15 FINAL INSPECTION**

- A. Thoroughly flush, clean, adjust, and balance the entire irrigation system. Upon 5 days written notice, demonstrate the entire system to the DEPARTMENT's Representative, proving that all valves and controls are properly operating and that the installed system is workable, clean, and efficient.
- B. Contractor to deliver to the DEPARTMENT the items scheduled for submittal at the time of the final inspection for irrigation.
- C. Upon completion of the installation, turn over specialty tools to the DEPARTMENT. Include a list of each part with appropriate part number (for ordering replacement products) and local supply store of where these parts can be purchased.

### **3.16 WARRANTY**

- A. The warranty period relating to all products, materials, and workmanship will begin on the date of final acceptance of the work and extend for the period of one year.
- B. The Contractor must repair or replace all defective materials and workmanship during the warranty period. The conditions of the warranty applies to all replacement material and repair work from the date such materials are installed or repair work done.

### **3.17 ADDITIONAL REQUIREMENTS**

- A. Provide DEPARTMENT's Maintenance Personnel with system familiarization and 4 hours minimum of instruction in maintenance and operation of each piece of equipment installed.

- B. Repair settling trenches. Include complete restoration of plantings, mulch, grades, pavements or other improvements.
- C. Fall Winterizing Visit: Return to the job site at the beginning of the first winter season to perform a general inspection of the system, test all lines, couplers , repair all leaks and faulty work, check operation of the system, adjust spray patterns for full coverage, drain system, show maintenance staff location of all drain valves and blow out points and restore all areas where trenches have settled.
- D. Spring Start-Up Visit: Return in spring after the first winter season for system check and if necessary, restore system for spring and summer operation. Explain system and operation methods to maintenance staff. Restore all areas where trenches have settled.

**END OF SECTION 32 8420**

**SECTION 32 91 13**  
**SOIL PREPARATION**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Furnish labor, material and equipment required for placement and amendment of topsoils for areas to be planted, and the establishment of finish grades as shown on the Drawings and as specified herein.
- B. Coordinate work with installation of other site work including earthwork, irrigation, seeding, and planting.
- C. Related sections, drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this section.

**1.02 DEFINITIONS**

- A. Finish Grade: Elevation of finished surface of amended topsoil soil.
- B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Amended Topsoil: Imported topsoil or surface soil modified with peat, soil amendments and fertilizers. See Part 2 – Products.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

**1.03 SUBMITTALS**

- A. Product Data. Include Material Safety Data Sheets (MSDS) where applicable: For the following:
  - 1. Fertilizers, including application rates.
  - 2. Soil Amendments.
  - 3. Herbicides.
- B. Samples for Verification: For the following:
  - 1. 1/2 cubic foot peat.
  - 2. 1/2 cubic foot of each imported topsoil. Furnish one sample from each site from which soil is to be furnished.
  - 3. 1/2 cubic amended topsoil.
- C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis for standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- D. Qualification Data: For testing agencies.
- E. Material Test Reports:
  - 1. Soil Fertility and Agricultural Suitability Analyses and Recommendations Reports for the following:
    - a. Existing on-site topsoil: From two typical locations as selected by DEPARTMENT, minimum 30 days prior to beginning soil preparation work.
    - b. Imported topsoil: Minimum 30 days prior to beginning soil preparation work.
    - c. Amended topsoils: Provide soil analyses and results for soil samples taken from two typical locations as selected by the DEPARTMENT, minimum 7 days after soil preparation work has been completed and prior to installing plants.

2. Peat Analysis: Provide analysis for one representative sample of peat minimum 30 days prior to peat being delivered to Project Site, and an analysis for one representative sample of peat delivered to the Project Site.
3. Soil Compaction Test: Provide results of soil compaction tests minimum of 7 days prior to planting and seeding.

F. Delivery Slips: Provide delivery slips as proof of shipment of specified materials.

#### **1.04 QUALITY ASSURANCE**

- A. Soil Fertility and Agricultural Suitability-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- B. Soil Analyses: Furnish soil analyses by a qualified soil-testing laboratory stating:
  1. Soil Composition: USDA particle size analysis indicating percentages of sand, silt and clay, and percent organic matter.
  2. Macro and micro nutrient fertility tests as determined by pH, salinity, nitrate nitrogen, ammonium nitrogen, phosphate phosphorous potassium, calcium, magnesium, soluble copper, zinc, manganese, iron, saturation extract boron and sodium analyses.
  3. Recommendations by the soil testing lab for fertilizer and soil amendments in pounds per 1,000 square foot or tons per acre, as necessary to correct soil deficiencies.
- C. Peat Testing Laboratory Qualifications: An independent laboratory, with the experience and capability to conduct the testing indicated following the U.S. Composting Council Seal of Testing Assurance (STA) procedures, or equivalent.
  1. Acceptable STA Peat Testing Laboratories are:
    - a. A & L Western Agricultural Laboratories, (503) 968-9225.
    - b. Control Laboratories, (831) 724-5422.
- D. Peat Analysis:
  1. Percent organic matter, percent moisture, percent inerts (foreign matter), pH, soluble salts, and particle size.
  2. Nutrient content, including: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg) and Sulfur (S).
  3. Trace Metals, including: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn).
  4. Maturity Indicator. Provide bio-assay results. Provide Carbon-Nitrogen ratio.
  5. Stability Indicator: Provide respiration test results.
- E. Request inspection and allow observation by DEPARTMENT of prepared soils before planting.
- F. Soil Compaction Testing: Furnish soil compaction standard tests per ASTM 698. Request inspection and allow observation by DEPARTMENT of prepared soils before planting.

#### **1.05 DELIVERY, STORAGE AND HANDLING**

- A. Deliver packaged materials in manufacturer's unopened containers fully identified by name, brand, type, weight and analysis.
- B. Store and handle packaged materials to prevent damage and intrusion of foreign matter.
- C. Store stockpiled topsoil in area designated by DEPARTMENT. Provide erosion control measures for stockpiled topsoil on site to prevent contamination of the soil and control of dust and erosion.

#### **1.06 SOIL AMENDMENT BID QUANTITIES**

- A. Bid quantities and types of soil amendments shall be based upon those listed in this Section. Types of amendments required and quantities shall be adjusted as necessary based upon actual results of soil fertility and agricultural suitability analyses and recommendations for on-site topsoils.

- B. Amount per 6-inch lift of topsoil over 1000 square-feet of landscape area:
1. 25 lbs. Gypsum (Calcium sulfate)
  2. 35 lbs. Calcium carbonate limestone 'Calpril'
  3. 35 lbs. Dolomite limestone 'Dolpril'
  4. 8 lbs. Treble superphosphate (0-45-0)
  5. 3 lbs. Ammonium nitrate
  6. 4 ozs. Zinc sulfate
  7. 8 ozs. Manganese sulfate
  8. 1 oz. Laundry Borax
  9. 6 cu-yds Compost

### 1.07 SITE CONDITIONS

- A. Topsoil placement and soil preparation shall not take place during periods where saturated soil or surface water is present in work areas.
- B. Work shall not take place when temperature is less than 32 degrees Fahrenheit, or when frozen soil exists on site.

### 1.08 COORDINATION

- A. Coordinate soil preparation with grading operations such that topsoil, soil amendments and fertilizers are incorporated into ground fill areas in specified lifts to specified depths below finish grade for both planting areas and lawn areas. Topsoils shall be amended per recommendations of the Soils Testing Laboratory.
- B. Coordinate work with installation of other site work, including irrigation, seeding, and planting.

## PART 2 - PRODUCTS

### 2.01 TOPSOIL

- A. Topsoil Definition: ASTM D 5268; natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles, conforming to USDA classification for Loam or Sandy Loam; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inches in any dimension; and free of weeds, roots, and other deleterious materials, with the following physical properties:
1. Organic Matter: 6 percent minimum.
  2. Saturation Extract concentration for Boron: less than 1.0
  3. pH range of from 6 to 8 (plus 0, minus 0.5).
  4. Saturation Extract Conductivity: less than 4.0 dS/m @ 25 degrees Celsius as determined in a saturation extract.
  5. Non-soil components: less than 1 percent by volume.
  6. Heavy metal concentrations: below the USDA per year load limit.
  7. Minimal weed seed.
    - a. If regenerative noxious weeds (including, but not limited to, quack grass, nutsedge grass, and horsetail) are present in the soil, all resultant growth including roots shall be removed throughout one-year period after acceptance of work at no additional cost to Owner.
  8. Import Topsoil: Manufactured topsoil from off-site source blended with 50 percent peat. Obtain topsoil and peat from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes unless prior planned development allows.

### 2.02 INORGANIC SOIL AMENDMENTS

- A. Dolomitic Lime: Natural, agricultural limestone (calcium and magnesium carbonate) containing a minimum of 20 percent calcium and 11 percent magnesium and as follows:

1. Screen Analysis: 100 percent passing through No.30 sieve; 70 percent passing through No. 100 sieve; and minimum 30 percent passing through No.325 sieve.
  2. Provide lime in form of granulated, prilled, dolomitic limestone, 'DoloPril' by Pacific Calcium, Inc., (877) 571-3555, or equal.
- B. Calcitic Lime: Natural, agricultural limestone (calcium carbonate) containing a minimum of 36 percent calcium and as follows:
1. Screen Analysis: minimum of 100 percent passing through No. 10 sieve and a minimum of 80 percent passing through No. 100 sieve.
  2. Provide lime in form of granulated, prilled, limestone, 'CalPril' by Pacific Calcium, Inc., (877) 571-3555, or equal.
- C. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
- D. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- E. Aluminum Sulfate: Commercial grade, unadulterated.
- F. Gypsum: Agricultural gypsum; minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.
- G. Sand: Clean washed river sand, free of calcium, chlorides and other deleterious substances.

### 2.03 ORGANIC SOIL AMENDMENTS

- A. Peat: Commercially manufactured, stable, and weed-free organic matter from agricultural, food, biosolids, or yard debris sources; pH range of 5.5 to 8.0; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and shall conform as follows:
1. Tested, at minimum, every six months for noxious weeds.
  2. Organic matter source (feedstock): Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
  3. Organic Matter Content: 60 to 80 percent of dry weight as determined by ash method.
  4. Moisture Content: 35 to 55 percent by weight
  5. Free of refuse (less than 1 percent by dry weight), plastics, contaminants or any material toxic to plant growth.

### FERTILIZER

- B. Fertilizer composition and rate to be determined based upon soil analysis. For bidding purposes, assume: 10 Nitrogen (N), 10 Phosphorus (P), 10 Potassium (K), 5 Sulfur (S) applied at a rate of 10 pounds per 1000 square feet in all planting beds and seeded areas.
- C. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid.
- D. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- E. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- F. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium derived from natural organic and inorganic sources in the following composition:

1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

#### **2.04 MISCELLANEOUS PRODUCTS**

- A. Post-Emergent Herbicide: "Round-Up" by Monsanto or equal.
- B. Contact Herbicide for controlling nutsedges: "Manage" by Monsanto.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION OF SITE CONDITIONS**

- A. Examine for site conditions that will adversely affect execution, permanence, quality of work, and survival of plant material and grasses.
- B. Verify that subgrades and slopes of lawn and planting areas are acceptable to DEPARTMENT prior to commencing work of this Section.
- C. Should the CONTRACTOR find any discrepancies between the Drawings and the physical conditions, inform the DEPARTMENT immediately for clarification.
- D. Begin Work required under this Section only after conditions are satisfactory.

#### **3.02 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and exterior plants designated to remain from damage caused by soil preparation operations.
- B. Prepare soils at a time when moisture conditions will permit proper cultivation.
- C. Remove stones over 1-inch diameter, sticks, roots, mortar, concrete, rubbish, debris, and all materials harmful to plant life, and legally dispose of them off Owner's property.
- D. Remove or spray as required to eradicate noxious weed growth and roots.
  1. Achieve complete removal or kill of all weeds within all areas receiving new plantings and lawn areas.
  2. In planting beds, kill achieved by working soil is permissible for annual non-noxious broad-leaf type weeds.
  3. Apply post-emergent herbicide over all areas of weed or grass growth within landscaped area to eradicate weed growth and roots. Apply in two applications at manufacturer's maximum recommended rate, as follows:
    - a. First application: Apply 7 days prior to performing soil preparation.
    - b. Second application (to kill new vegetation): Apply after soil preparation has been completed and minimum of 48 hours prior to planting.
    - c. Observe manufacturer's recommended period prior to working in treated areas.
  4. Apply contact herbicide directly onto foliage of nutsedges. Do not spray.
- E. Locate and securely mark or flag irrigation sprinkler heads, area drains, catch basins, clean outs, manholes, valve boxes, and other site improvements not extending above finish grade.

#### **3.03 SOIL PREPARATION FOR PLANTING AREAS**

- A. This article pertains to those shrub bed areas indicated as "Shrub and Groundcover Planting Areas" on the Drawings where mass plantings of trees, shrubs and ground cover plants are scheduled.
- B. Prepare subgrades by excavating and removing soil, rock and other construction material to 18 inches below finish grade. Cross-rip subgrades to a further depth of an additional 6 inches prior to placing topsoil.
- C. Place 6 inches topsoil, peat, soil amendments, and fertilizers as recommended in Agricultural Soil Suitability Report per 1,000 square feet and rototill thoroughly to a depth of 8 inches. Compost shall constitute 5% of the amended soil using an amending rate of 1-1/2 cubic feet per

cubic yard. Place remainder of topsoil, compost, soil amendments, and fertilizers as recommended in Agricultural Soil Suitability Report per 1,000 square feet and rototill thoroughly to a depth of 8 inches, allowing for compaction, natural settlement, and depth of specified mulch.

- D. Water lightly and allow planting mix to settle. Add additional material at mixture indicated in paragraph above to bring soil level to grades shown on the Drawings with allowance at pavement edges for mulch placement. Provide compaction to 85 percent relative density.
- E. Meet lines, grades and elevations shown, after light rolling and natural settlement. Fine grade shrub and ground cover areas to smooth even surface with loose, uniformly fine texture. Rake and drag shrub and ground cover areas to remove ridges and fill depressions to obtain firmness and finish grades preparatory to receiving planting.
- F. Remove stones over 1/2-inch in any dimension and sticks, roots, rubbish and other extraneous matter during final raking, prior to planting.

### **3.04 SOIL PREPARATION FOR SEEDED LAWNS**

- A. This article pertains to new lawns and grasses as shown on Drawings and existing lawn and grass areas disturbed by construction activities.
- B. Prepare subgrades by excavating and removing soil, rock and other construction material to 4 inches below finish grade. Cross-rip subgrades to a further depth of 6 inches prior to placing topsoil.
- C. Place topsoil and compost as recommended in Agricultural Soil Suitability Report per 1,000 square feet. Rototill thoroughly to a depth of 6 inches, tilling topsoil into top 2 inch layer of subsoil. Place sufficient topsoil allowing for compaction and natural settlement.
- D. Place remaining soil amendments, and fertilizers as recommended in Agricultural Soil Suitability Report per 1,000 square feet.
- E. Unless already required by the recommendations of the Agricultural Soil Suitability Report apply the following additional soil amendments:
  - 1. Compost: 1 inch minimum depth
  - 2. Calpril Lime: 12.0 pounds. per 1,000 square feet
- F. Incorporate remaining soil amendments into topsoil of lawn areas to a total depth of 4 inches.
- G. Leveling Rolling: Drag with flexible tine harrow (or approved equipment) to remove ridges and fill depressions, as required to meet finish grades. Roll areas (minimum roller weight 10 pounds per square inch) in two opposing directions.
- H. Repeat rolling procedures and drag lightly to establish a smooth uniform compacted surface free of rocks and other extraneous matter. Provide compaction to 85 percent relative density.
- I. Water lightly and allow planting mix to settle. Add additional material at mixture indicated in paragraph above to bring soil level to grades shown on the Drawings with allowance at pavement edges. Provide compaction to 85 percent relative density.
- J. Meet lines, grades and elevations shown, after light rolling and natural settlement. Fine grade lawn areas to smooth even surface with loose, uniformly fine texture. Rake and drag lawn areas to remove ridges and fill depressions to obtain firmness and finish grades preparatory to receiving lawn planting.
- K. Remove stones over 1/2-inch in any dimension and sticks, roots, rubbish and other extraneous matter.
- L. Finish Grading: Grade lawn areas to smooth, even surface with a loose uniformly fine texture. Finish grade of soil shall be 1/2 inch below adjacent pavement. Limit preparation to areas which will be planted promptly after preparation.

- M. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.
- N. Restore seed bed areas to specified condition if eroded, hardened or glazed by the cycle of precipitation and drying or in any manner otherwise disturbed after fine grading has been completed and prior to commencing seeding operations. Restoration of seed bed areas shall be considered as incidental to the project Work and shall be completed at no additional cost to the Owner.

### **3.05 SOIL PREPARATION FOR PLANTING PITS OF TREES**

- A. This article pertains to tree planting when occurring on an individual basis.
  - 1. Backfill Mix: Prepare backfill mix and place in planting pits as specified in Division 32 Section "Plants."
  - 2. Grade smooth to elevations shown.

### **3.06 SOIL PREPARATION UNDER EXISTING TREES**

- A. Remove vegetation not indicated to remain beneath canopy of existing trees. Take care not to disturb roots of existing trees.
- B. Lightly rake areas and add amended topsoil to meet proposed grades.

### **3.07 FINE GRADING**

- A. Finish grade after full settlement including mulch, shall be 1 inch below tops of curbs, walks, or existing grades in shrub areas and 3/4 inch lower in lawn areas.
- B. Slope all areas to prevent puddling and drain surface water toward catch basins, drains, curbs, or off-site as shown on Drawings.
- C. Soil in all areas shall be thoroughly settled, with a smooth surface free of humps and hollows, and shall be firm enough to resist undesirable impressions when stepped upon.
- D. Use levels, screens, drags, or any other equipment necessary to establish and verify grades and surfaces.
- E. Finish grade lawn, grass and planting areas to smooth, even surface with loose, uniformly fine texture.
- F. Roll, rake, and drag lawn areas, remove ridges and fill depressions with amended topsoil to obtain firmness and finish grades as indicated.
- G. Notify DEPARTMENT 36 hours in advance to review fine grading of lawn, grass and planting areas. Finish grades shall be prepared to the satisfaction of the DEPARTMENT prior to planting.
- H. See Division 32 Section "Plants," for mulch placement.

### **3.08 CLEAN-UP**

- A. Clean up excess materials and debris from project site upon completion of work or sooner if directed by the DEPARTMENT.
- B. Leave in neat and tidy condition daily.

### **3.09 DISPOSAL**

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

**END OF SECTION**

**SECTION 32 92 13**  
**SEEDING LAWN AND GRASSES**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Seeding.
  - 2. Herbicides.
  - 3. Erosion-control material(s).
- B. Related Sections, Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this section.

**1.02 GENERAL REQUIREMENTS**

- A. Comply with governing regulations applicable to landscape materials.
- B. Do not make substitutions. If specified landscape material is not obtainable, submit to the DEPARTMENT proof of non-availability and material proposed for use as equivalent material.
- C. Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitation for each kind of landscape work required.

**1.03 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Submit within 30 days from Award of Contract the following:
  - 1. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
  - 2. Vendor's proof of order for each seed mix specified. Deliver the seed bag tags to DEPARTMENT.
  - 3. Fertilizers: Submit manufacturer's guaranteed analysis.
  - 4. Mulch: Submit samples and vendor's product certificates for top dressing mulch and hydroseed mulch.
  - 5. Submit copy of herbicide applicator's Commercial Applicator's License to the DEPARTMENT before application of herbicides (includes pesticides). Submit a copy of the application record to the DEPARTMENT immediately after each herbicide or pesticide application.

**1.04 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

**1.06 PROJECT CONDITIONS**

- A. Coordinate work with installation of other site work including irrigation and planting.
- B. Verify site conditions that will not adversely affect execution. Verify that soil preparation has been completed and irrigation systems have been installed.

- C. Architect shall determine areas beyond those shown on Drawings disturbed by construction that are to be prepared and seeded at no additional cost to the Owner.
- D. Observe the conditions under which Work is to be performed, and notify the DEPARTMENT of unsatisfactory conditions. When conditions detrimental to lawn growth are encountered, such as rubble, rock fill or adverse drainage conditions, notify the DEPARTMENT before planting or adding soil amendments. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the DEPARTMENT. Should any conditions not mentioned on the Drawings be found to exist, notify the DEPARTMENT immediately.
- E. Environmental Requirements: Do not place, spread, or roll fill materials during unfavorable weather conditions. When work is interrupted by adverse weather conditions, do not resume fill operations until moisture content and density of fill are satisfactory.
- F. Protection of subgrade: Do not allow equipment to pump or rut subgrade, stripped areas, footing excavations or other areas prepared for the Project. Protect subgrades, fills and excavation areas from surface waters flowing into the work areas.
- G. Season: Seeding shall take place in normal weather and temperatures that are appropriate and typical for such work, generally between April 21st and September 1st. Seeding on other dates or during adverse conditions is at the risk of the CONTRACTOR. Do not sow seed when weather conditions are unfavorable, such as during drought, heavy rain or high winds.
- H. Continuity of Soil Preparation and Seeding: Proper establishment of turf requires that seeding occur as soon as practicable after completion of fine grading. A properly cultivated and finely graded soil surface can be jeopardized or damaged if allowed to lie fallow or unseeded. Seeding shall therefore begin within 72 hours of approval of final grades. If rainfalls of greater accumulation than 0.25-inches occur within this time period, then the soil surface shall be examined after drying to determine if glazing or crusting has occurred. Any seedbed areas greater than 6-inches in any dimension which appear smooth or glazed shall be recultivated. If glazing is apparent throughout the seedbed area, the entire surface shall be cultivated or raked again to establish a friable soil surface. If seeding is delayed for more than 72 hours, recultivation and raking for finish grade shall also be required if puddling or glazing of the soil surface is apparent. Any and all reraking and supplemental cultivation shall be considered as incidental to the project Work and shall be performed at no additional cost to the Owner.

#### **1.07 PROTECTION**

- A. Provide adequate measures to protect workers and passers-by the site. Execute all work in an orderly and careful manner with due consideration for any and all surrounding areas, plantings, or structures which are to remain. Protect all adjacent property and improvements from work damage, and replace any portions damaged.
- B. Any structures or facilities damaged due to Work of this Section shall be restored equal or better to their original condition at CONTRACTOR'S expense and to the satisfaction of the DEPARTMENT at no additional cost to the Owner.

#### **1.08 WARRANTY**

- A. Guarantee seeded lawns and grasses in writing for a period of 2 years, or to the end of one full growing season after date of Final Acceptance, whichever is longer. Maintain and protect seeded lawns and grasses from damage until date of Final Acceptance. This shall include damage caused by vandalism or adverse weather conditions.
- B. Remove and replace seeded lawns and grasses found to be dead, having low germination or growth rates, or in unhealthy condition during and at the end of warranty period. All replacement work shall be made within 14 days after receiving notification by the DEPARTMENT, weather permitting. Provide new seeded lawns and grasses which comply with the Drawings and specifications, at no additional cost to the Owner. Guarantee replacement seeded lawns and grasses for 1 year from the date of seeding as specified above.

- C. In the event the CONTRACTOR does not make repairs accordingly, the Owner without further notice may provide materials and labor to make such repairs at the expense of the CONTRACTOR at no additional cost to the Owner.

## **PART 2 - PRODUCTS**

### **2.01 SEED**

- A. General: provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America.
- B. Grass Seed Mix: Subject to compliance with requirements, provide the following proprietary seed mix: 1/3 Nugget Bluegrass, 1/3 ArctaRed Fescue and 1/3 Boreal Fescue.

### **2.02 TOPSOIL**

- A. Topsoil: See Division 32 Section "Soil Preparation."

### **2.03 INORGANIC SOIL AMENDMENTS**

- A. Inorganic Soil Amendments: See Division 32 Section "Soil Preparation."

### **2.04 ORGANIC SOIL AMENDMENTS**

- A. See Division 32 Section "Soil Preparation."

### **2.05 TOP DRESSING**

- A. Top dressing for hand seeding small areas where machine seeding is not feasible (not needed with seeding machine or hydroseeding):
  1. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed peat moss, having a water-absorbing capacity of 1100 to 2000 percent.
  2. Compost: See Division 32 Section "Soil Preparation."

### **2.06 HERBICIDES**

- A. Post-Emergent Herbicides: EPA registered and approved, of type recommended by manufacturer for selective weed eradication. "Round-Up," or approved equal.

### **2.07 FERTILIZER**

- A. Meet requirements of applicable State fertilizer laws. Fertilizers shall be uniform in composition, dry and free flowing. Deliver to the site in original unopened containers each bearing manufacturer's guaranteed analysis.
- B. Composition and rate of fertilizer used to amend topsoil is to be determined by soil analyses. Refer to Division 32 Section "Soil Preparation" for soil fertility testing requirements.
- C. Commercial Fertilizer: Slow release, granular fertilizer that is derived from natural organic and inorganic sources
  1. Starter Fertilizer: Woodburn Fertilizer 'Perfection Mix #29' 15-15-15 w/Minors, as available from Woodburn Fertilizer, Woodburn; Oregon; Tel.: 1-888-253-3255, or equal.
  2. Maintenance Fertilizer: Woodburn Fertilizer 'Regal Green' 21-4-21 with 50 percent of the nitrogen controlled release from superior Duration™ Type II, as available from Woodburn Fertilizer, Woodburn, Oregon; Tel.: 1-888-253-3255, or equal.

### **2.08 MULCHES**

- A. Peat Mulch: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed peat moss, having a water-absorbing capacity of 1100 to 2000 percent.
- B. Compost Mulch: See Division 32 Section "Soil Preparation."

- C. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 3.8 to 6.8.
- D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

## **2.09 TEMPORARY BARRICADE MATERIALS**

- A. Agricultural metal stakes, minimum 42-inch exposed height.
- B. Twine or wire.
- C. Plastic flagging tape, 12-inch lengths.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
  - 2. Protect grade stakes set by others until directed to remove them.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### **3.03 LAWN AREA PREPARATION**

- A. See Division 32 Section "Soil Preparation."
- B. All seeding shall be completed after May 1st and prior to August 15th, or the contract deadline, whichever is sooner. Seeding other than the specified dates will be allowed only with prior written permission of the DEPARTMENT and will be at the CONTRACTOR's own risk. If the seeding fails to produce a uniform and fecund growth, the seeding will be repeated until the required growth is achieved.

### **3.04 HERBICIDE APPLICATION**

- A. Spray post-emergent herbicides as required to eradicate and prevent emergence of noxious weed growth.
  - 1. Apply post-emergent herbicides over all areas of weed or grass growth within landscaped area to eradicate weed growth. Apply in single application at manufacturer's maximum recommended rate, as follows:
    - a. Apply after soil preparation has been completed and approved by the DEPARTMENT.
    - b. Do not till pre-emergent herbicide into soil.
    - c. Observe manufacturer's recommended period prior to working and seeding in treated areas.

### **3.05 SEEDING NEW LAWNS**

- A. Notify the DEPARTMENT for approval of seed bed prior to seeding.
- B. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

- C. Apply Starter Fertilizer at a rate of 1 pound of actual Nitrogen per 1,000 square feet immediately prior to sowing seed. Do not sow seed and fertilizer simultaneously.
  - 1. Include Starter Fertilizer in hydroslurry mix.
- D. Sow seed using a drill seeding machine that places seed into soil. Do not seed when wind velocity exceeds 5 miles per hour. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 1. For small areas where seeding machine is not feasible, use seed broadcaster and hand rake seed into soil.
- E. Finish Lawn: sow seed mixture and water thoroughly.
- F. Protect any non-hydroseeded areas with slopes with a gradient not exceeding 4 horizontal to 1 vertical by spreading straw mulch. Spread uniformly at a minimum rate of 100 pounds per 1,000 square feet to form a continuous blanket approximately 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- G. Top Dressing: (Not needed with seeding machine or hydroseeding). Protect hand seeded areas from hot, dry weather or drying winds by applying compost mulch or peat mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a depth of 3/16 inch and roll surface smooth. Cover area evenly with top dressing at the rate of two 4-cubic foot peat moss bales per 1,000 square feet of area, or equivalent density cover with compost.
- H. Reseeding: Reseed areas failing to show uniform stands of grass at 10-day intervals until a satisfactory stand is achieved.

### 3.06 HYDROSEEDING

- A. Seed lawns with hydroseeding equipment and also where gradient of slope of planting area exceeds 3 horizontal to 1 vertical. Method shall be approved by the DEPARTMENT.
- B. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch with tackifier in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Areas with slope gradient less than 3 horizontal to 1 vertical: Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 2000 pounds per acre, dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
  - 2. Areas with slope gradient equal or greater than 3 horizontal to 1 vertical: Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 1000 pounds per acre, dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 2000 pounds per acre.
- C. Keep hydromulch and seed out of planting beds and off walks, structures and areas not to be seeded. Clean up overspray of hydromulch onto these areas. Keep mulch and seed out of plant beds and other areas by mechanical means or selective herbicide if encroachment occurs. Clean up these areas to the satisfaction of the DEPARTMENT.

### 3.07 LAWN MAINTENANCE

- A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, edging, trimming, replanting, and other operations necessary to establish a stand of grass to the satisfaction of the DEPARTMENT. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.
  - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

- B. Weed Eradication: Remove germinated lawn seed in planting areas without harming other plant material. Spray under and 6 inches outside of fences with "Roundup" to kill all grasses and weeds.
- C. Duration: Maintenance of the seeded lawn shall commence after preliminary observation and approval of the seed bed by the DEPARTMENT, and continue for the period of time outlined within Division 32 - Section "Establishment Maintenance" following written Notice of Substantial Completion of the Project and until Final Acceptance, whichever is later.
- D. Establishment: If lawns are not established before the dormant period, maintain for a period of 60 calendar days minimum after the dormant period and until Final Acceptance. For the purposes of this Section the dormant period is September 30th to April 15th.
- E. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches. Note that design intent is to have operating automatic irrigation system in place prior to any seeding operations.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water lawn with fine spray at a minimum rate of 1.5 inches per week unless rainfall precipitation is adequate.
- F. Mowing: Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. All grass clippings shall be collected and disposed of off-site in a legal manner. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Finish Lawn: Once growth has reached 4 inches, mow and cut no more than 1/3 total height of grass. Mow weekly thereafter to maintain a height of between 1-1/2 to 2 inches. Maintain until Final Acceptance.
- G. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
  - 1. Fertilize lawns at end of 30 days with Maintenance Fertilizer at the rate of 1 pound per 1,000 square feet.
  - 2. Continue fertilizing lawns at 30 days intervals with Maintenance Fertilizer at the rate of 1 pound per 1,000 square feet until the end of the Maintenance Period.

### **3.08 SATISFACTORY LAWNS**

- A. Lawn installations shall meet the following criteria as determined by the DEPARTMENT:
  - 1. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, dense stand of grass has been established, free of weeds and surface irregularities, humps and depressions, with coverage exceeding 95 percent over any 10 sq. ft. and bare spots (soil exposed) not exceeding 2 by 2 inches.
- B. Ensure that seed establishment occurs prior to October 1st. Lawns that are not satisfactorily established at this time shall be sodded at no additional cost to the Owner.
- C. Where observed landscape work does not comply with the requirements, replace rejected work and use specified materials to reestablish lawns and continue maintenance until lawns are satisfactory.

### **3.09 CLEANUP AND PROTECTION**

- A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from foot and vehicular traffic and to protect against trespassing and damage. Maintain

fencing and barricades throughout initial maintenance period and remove after lawn is established.

- C. Remove nondegradable erosion-control measures after grass establishment period.

**END OF SECTION**

## SECTION 32 93 00 PLANTS

**SECTION 329300****PLANTS****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section Includes:
  - 1. Trees.
  - 2. Shrubs.
  - 3. Ground Cover.
  - 4. Herbicide.
  - 5. Planting Fertilizers.
  - 6. Mulches.
  - 7. Root Barriers.
  - 8. Tree Stabilization.
  - 9. Planting Accessories.
- B. Related Sections, Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections apply to this section.

**1.02 REFERENCES**

- A. Standards: Comply with botanical names, sizes, and conditions provided in:
  - 1. Botanical Names: American Joint Committee on Horticultural Nomenclature, "Standardized Plant Names."
  - 2. Sizes and Conditions: ANSI Z60.1 "American Standards for Nursery Stock", (latest edition).
  - 3. Perennials: "Perennial Plant Association Standards."

**1.03 QUALITY ASSURANCE**

- A. CONTRACTOR: Provide one person who shall: Be present at all times during execution of work in this section; be familiar with the materials and best methods for installation; direct work performed under this section.
- B. Government Inspection: All plants and planting material shall meet or exceed the specifications of Federal, State, and County laws requiring inspection for plant disease and control.
- C. Secure plant material and maintain in a climate similar to that of the project site for a minimum period of one year.
- D. All plant material to be grown from cuttings or seed. Collected plants are not acceptable.

**1.04 SUBMITTALS**

- A. Within 30 days after Contract award, submit:
  - 1. A list of local/regional suppliers for each plant species to be installed. List to include plant quantities, sizes and root conditions. Certify in writing, confirmed orders for plants by submitting a Bill of Sale for each plant to be installed. Each plant species shall be supplied by one grower only unless otherwise approved by the DEPARTMENT.
    - a. Requests for substitutions of plants not available in size, quantity or type specified must be made within 30 days after Contract award. Submit written evidence that a specified plant cannot be obtained and has been unobtainable since Contract award.
  - 2. Plant Material Inspection Certificates for all plant material shipped from out of state.
  - 3. 1/2 cubic foot sample of bark mulch for approval prior to delivery.
  - 4. Product Data: For the following:
    - a. Bark mulch.
    - b. Anti-desiccant.
    - c. Post-emergent herbicide.

- d. Pre-emergent herbicide.
  - e. Fertilizer tablets.
  - f. Tree stabilization products.
  - g. Mycorrhizal inoculum.
5. Submit copy of herbicide applicator's Commercial Applicator's License to the DEPARTMENT before application of herbicides (includes pesticides). Submit a copy of the application record to the DEPARTMENT immediately after each herbicide or pesticide application.
- B. Shrub and Tree Samples: Typical samples, three each of all varieties and sizes (5 gallon and under for shrubs, 15 gallon and under for trees) of all plant materials shall be delivered to the site a minimum of fifteen (15) days prior to planting operations. Photos of these same plants shall be submitted to the Landscape Architect for simultaneous review and approval prior to scheduled planting operations. Approved plant samples shall remain on site and shall be maintained by the CONTRACTOR as standards of comparison for plant materials to be furnished. Approved samples shall be incorporated into the work.
- C. Upon completion of the Work, submit:
1. Written notification to the DEPARTMENT requesting review for Substantial Completion.
  2. Written notification to the DEPARTMENT of Punch List Completion.
- D. With application for final payment, submit:
1. Duplicate copies of delivery invoices, labels, or other acceptable proof of quantities of materials used.
  2. Copies of delivery invoices, labels, or other proof of quantities of plant materials and fertilizers.

#### **1.05 SITE OBSERVATION**

- A. Site observations herein specified shall be made by the DEPARTMENT. The CONTRACTOR shall provide a minimum of three (3) days notice before Observation is required.
1. Pre-final observation after planting, and all other indicated or specified work has been completed—Substantial Completion—acceptance and written approval shall establish beginning of the Maintenance Period.
  2. Final Observation—Final Acceptance—at the completion of the Maintenance Period. Successful completion of this observation shall establish the beginning date for the guarantee of all trees.
- B. Upon completion of the Final Observation and the Work of this Section, the CONTRACTOR will be notified in writing: (1) whether the work is acceptable; and (2) of any requirements or corrective measures necessary for completion and acceptance, i.e. Punch List.
- C. CONTRACTOR shall be on site at the time of each observation visit.
- D. No site visits shall commence unless all items in previous observation reports are either completed or remedied unless Owner has waived, in writing, such compliance. Failure to accomplish Punch List requirements shall make Landscape CONTRACTOR responsible for reimbursement to the Architect for time and travel at current billing rates.
- E. Construction observation visits shall be made in proper sequence of the installation of the work. No visits will be made until all soil submittals have been made and approved. Out of sequence construction visits shall make the Landscape CONTRACTOR responsible for reimbursement to the Architect for time and travel at current billing rates.

#### **1.06 QUALITY CONTROL**

- A. Inspection: Plants shall be subject to inspection by the DEPARTMENT at the job site upon delivery to the site. Plants not conforming to specifications shall be rejected and removed immediately from the site.

- B. The presence of noxious weeds in plant balls shall be cause for rejection of any or all plants from that supply source.

#### **1.07 DELIVERY**

- A. Deliver packaged materials to site in original unopened containers bearing manufacturer's guarantee chemical analysis, name, trade name, and trademark.
- B. Remove unacceptable plant material immediately from project site.
- C. Plant Materials:
  - 1. Deliver trees and shrubs after preparations for planting have been completed, and plant immediately.
  - 2. Do not prune prior to delivery unless otherwise approved by the DEPARTMENT.
  - 3. Do not bend or bind-tie trees or shrubs in such a manner as to damage bark, break branches, or destroy natural shape.
  - 4. Provide protective covering during delivery.
  - 5. Protect plants during delivery to prevent damage to root ball or desiccation of leaves.
  - 6. Apply anti-desiccant using a pump sprayer to provide adequate film over trunks, branches, stems, twigs and foliage of plants.
  - 7. If deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving, and sprayed again 2 weeks after planting.
  - 8. Label one of each tree and shrub species with securely attached waterproof tag bearing botanical name and supplier's name.

#### **1.08 STORAGE**

- A. CONTRACTOR shall schedule and conduct planting operations to minimize storage of plant materials on the project site. The location and conditions of storage shall be reviewed for approval by the CONTRACTOR, Owner, and the DEPARTMENT.
- B. Plants that cannot be planted within one day after arrival shall be "heeled-in" in accordance with accepted horticultural practices and the following requirements:
  - 1. Protect root ball of balled and burlapped plants with moist earth, sawdust or other acceptable material.
  - 2. Protect plant at all times from injury, extreme weather conditions, and keep moist.
  - 3. Store plants in shade until planted.
  - 4. Store plants in upright position and allow sufficient ventilation.
- C. All plants that are to be stored longer than one month shall be planted in nursery rows and maintained at the CONTRACTOR's expense.

#### **1.09 HANDLING**

- A. Do not drop plants.
- B. Do not pick up container or balled plants by stems, trunk, or foliage. Handle balled and burlapped plants by the ball of earth.

#### **1.10 NOTIFICATIONS**

- A. Notify the DEPARTMENT a minimum of 48 hours in advance of plant material delivery so that plants may be inspected upon site delivery. Unapproved materials to be immediately removed from job site.
- B. Notify the DEPARTMENT a minimum of one week in advance for request of Substantial Completion and Final Acceptance inspections.

#### **1.11 SITE CONDITIONS**

- A. Existing Improvements to Remain: Locate underground utilities prior to start of work.
- B. Protect existing improvements from damage, soiling or discoloration. Repair or replace damaged, soiled or discolored improvements as directed by the DEPARTMENT.

- C. Planting Conditions: Planting not permitted during the following conditions, unless otherwise approved:
1. Cold weather: less than 32 degrees Fahrenheit.
  2. Hot weather: greater than 80 degrees Fahrenheit.
  3. Wet weather: saturated soil.
  4. Windy weather: wind velocity greater than 20 m.p.h.

#### 1.12 WARRANTY

- A. Warrant all plant material to be true to botanical name and specified size.
- B. After receiving notice of Substantial Completion, maintain all plant material in a vigorous condition for 2 years according to the requirements outlined in Division 32 Section "Establishment Maintenance".
- C. Immediately replace plant material which is dead, not surviving or in poor condition in accordance with these specifications during current or if necessary, next planting season and at no cost to the Owner for a period of one year from the date of Substantial Completion. CONTRACTOR shall provide, at his expense, a timely written diagnosis of plant health by a certified Arborist, should a dispute arise concerning plant vitality or viability. Arborist's report shall indicate reason for lack of vigor, potential remedies, if any, and estimated time required to regain vigor and specified size.
- D. Plants used for replacement shall be same kind and size as originally specified and shall be furnished, planted and fertilized as originally specified.
- E. CONTRACTOR shall repair at no additional cost to the Owner, all damage to vegetation, site improvements and property caused by replacement of plant materials during the Maintenance Period.

#### 1.13 ACCEPTANCE

- A. Substantial Completion:
1. Notify the DEPARTMENT in writing of the completion of planting and ancillary landscape work.
  2. Within 10 days after notification of completion of work, the DEPARTMENT will inspect the work and prepare a Notice of Substantial Completion, along with a list of items that require completion or correction (Punch List).
  3. Notice of Substantial Completion constitutes the commencement of the Maintenance Period.
- B. Final Acceptance:
1. Final inspection of all planting will be made by the Owner, DEPARTMENT and the CONTRACTOR. Prior to executing a final inspection, the CONTRACTOR must furnish the DEPARTMENT with written documentation identifying how each Punch List item has been corrected. If such written documentation is not provided to the DEPARTMENT, all requirements of the Maintenance Period shall remain in force indefinitely until such time as the written documentation is received. Any extension of the Maintenance Period due to the failure of the CONTRACTOR providing written documentation of Punch List completion will be considered incidental to the Work and shall be performed by the CONTRACTOR at no additional cost to the Owner.
  2. Before Final Acceptance is granted the following must be completed by the CONTRACTOR and receive approval from the DEPARTMENT :
    - a. Written documentation identifying how each item on the Punch List has been corrected.
    - b. Replacement planting and correction of all items identified on the Punch List prior to expiration of the specified Maintenance Period.
    - c. The project site must meet all conditions stipulated within the "Maintenance" and "Clean Up and Protection" sections of the specifications.

3. If Final Acceptance is not granted at the end of the specified Maintenance Period, the CONTRACTOR shall continue maintaining plantings until Final Acceptance is granted, at no additional cost to the Owner.
- C. Necessary Observations Beyond Final Acceptance:
1. If any of the items identified on the Notice of Substantial Completion and Punch List have not been fully corrected or repaired to the complete satisfaction of the DEPARTMENT, the CONTRACTOR must schedule a field observation to substantiate claim of correction. The CONTRACTOR shall bear financial responsibility to reimburse the Owner for all time and travel costs incurred by the DEPARTMENT to confirm Punch List compliance.

## **PART 2 - PRODUCTS**

### **2.01 PLANT MATERIALS**

- A. Provide plant materials as scheduled on Drawings.
- B. Quantities indicated are for CONTRACTOR's convenience only. CONTRACTOR to verify and provide number of plants required to complete work graphically shown on Drawings.
- C. Sizes and grade quality are minimums as listed. Larger sizes may be acceptable if approved in writing by Owner. No additional payment is authorized for up-sized plant material.
- D. Plants shall be vigorous, well-formed and shaped, true to species and type, and free from disease, insects, and defects such as knots, girdled roots, poor branch attachment, sun-scald, windburn, injuries, abrasion, significant trunk scars, evidence of poor pruning, or disfigurement.
- E. Plants shall be full foliated when in-leaf.
- F. Christmas tree stock shall not be used for conifer, evergreen material.
- G. Conform to ANSI Z60.1, with additions and exceptions noted:
  1. Groundcover Plants: Well-established root systems, and grown in flats or removable containers.
  2. Containerized Plants: Grown in container in which delivered for at least 3 months, but not root-bound.
  3. Greenhouse Grown Plants: Acclimated outdoors for 360 days prior to delivery.
  4. Bare-root Stock: Well-branched, fibrous root system.
  5. Balled and Burlapped Plants and Containerized Trees: All evergreen trees and deciduous trees over 1-1/2 inch caliper to be balled and burlapped with hemp burlap and twine only or grown in container in which delivered for 9 months minimum. Soil balls to be a minimum of 10 inches per caliper inch of tree.
  6. Trees: Straight-trunked not varying from plumb more than 6 inches over 6 feet; well-branched, with no cross branches, dead or broken leaders, or broken major branches, no fresh cuts over 1 inch diameter, and not "topped" or sheared.
  7. Grafted Trees: Base grafted or budded only.

### **2.02 HERBICIDES**

- A. Post-Emergent Herbicides: EPA registered and approved, of type recommended by manufacturer for selective herbicide application. "Round-Up," or approved equal.

### **2.03 PRE-PLANT FERTILIZER**

- A. (1-10-10) shall be a combination of natural organic and inorganic granular fertilizers, free-flowing, and shall contain the following minimum available percentage by weight of plant food:

Nitrogen	1.0% minimum
Phosphoric Acid	10.0% minimum
Potash	10.0% minimum

#### **2.04 POST-PLANT FERTILIZER**

- A. (7-9-4) shall be a long-lasting, organic and controlled release plastic-coated, uniform in composition, free-flowing and shall contain the following minimum available percentages by weight of plant food.

Nitrogen	7.0% minimum
Phosphoric Acid	9.0% minimum
Potash	4.0% minimum

#### **2.05 FERTILIZER TABLETS**

- A. 20-10-5 slow release plant tablets, 10 gram size. Agriform or equal (no known equal).

#### **2.06 MULCH**

- A. Provide standard, commercially produced, medium-course, dark brown, bark mulch. Bark shall be ground fir or hemlock bark of uniform color, free from weeds, seed, sawdust, and splinters and shall not contain resin, tannin, or other compounds detrimental to plant life. All material shall pass a 1-inch mesh screen.

#### **2.07 ANTI-DESSICANT**

- A. Emulsion type, film-forming agent designed to permit plant transpiration but retard excessive loss of moisture from plants. "Wilt-Pruf" or equal.

#### **2.08 PLANTING SOIL MIXES**

- A. Refer to Division 32, Section "Soil Preparation."

#### **2.09 TREE STAKING AND GUYING**

- A. Deciduous Tree Tie: Plastic chain-type, minimum 1 inch wide by 1/8 inch thick.
- B. Evergreen Tree Guy Wire: 12 gauge galvanized wire with 1/2 inch rubber hose collar, black color, to protect tree trunk.
- C. Stakes: 2 inch x 2 inch x 8 feet pine or fir for staking of deciduous trees; and 2 inch x 2 inch x 36 inch pine or fir for guying of coniferous trees. Stain dark brown with water-based commercial wood stain prior to installation.
- D. Provide miscellaneous hardware, wire, and accessories as shown on the Drawings.
- E. PVC Flags: 1/2 inch or 3/4 inch diameter x 18 inches long PVC pipe.

#### **2.10 MYCORRHIZAL INNOCULUM**

- A. Available Products:
1. 'MycoApply Endo Plus' granular mycorrhizal inoculum. Available from: Mycorrhizal Applications, Inc., Grants Pass, OR (541) 476-3985.
  2. 'PHC Plant Saver' blend of ecto and endomycorrhizal fungal spores, beneficial rhizosphere bacteria, 4-7-4 fertilizer, organic amendments, and micronutrients. Available from Plant Health Care, Inc. (800) 421-9051.
  3. Or equal.

### **PART 3 - EXECUTION**

#### **3.01 PREPARATION**

- A. Verify finish grades are properly achieved and soil preparation has been completed in accordance with the specifications; start of Work denotes acceptance by the CONTRACTOR and CONTRACTOR assumes responsibility for final results.

#### **3.02 SOIL PREPARATION**

- A. As specified in Division 32 Section "Soil Preparation".

#### **3.03 LAYOUT**

- A. Mark locations of trees and shrubs for approval by the DEPARTMENT prior to digging. The method of marking shall be approved by the DEPARTMENT. After approval of layout, field place trees and shrubs in locations shown on Drawings. DEPARTMENT may request rotation or slight movement of tree to give a better appearance with respect to adjacent plants and structures. Placement must meet approval of the DEPARTMENT prior to excavating planting pits.

### 3.04 EXCAVATION FOR TREES AND SHRUBS

- A. Excavate planting holes, with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation.
- B. For trees and shrubs, make excavations at least 2 times wider than root spread; equal to the rootball height directly beneath the rootball; and 1-1/2 times deeper than rootball height around the perimeter of the planting pit, as indicated in the Drawings.
- C. If non-percolating soils are encountered, fill excavations for trees and shrubs with water and allow to percolate out before planting. If plant holes do not drain: Auger drill holes 36 inches deep by 8 inches wide and fill with drainage backfill. Cover top with filter fabric. Notify the DEPARTMENT to observe prior to planting.
- D. If conditions detrimental to plant growth are encountered, such as rubble fill, or obstructions, notify the DEPARTMENT and resolve before planting.
- E. Scarify bottom and sides of hole with shovel to eliminate "glazed" or compacted surfaces.
- F. Set plants on native soil where possible.

### 3.05 PLACING

- A. Set top of root ball slightly higher than finish grade; deep planting not permitted. If hole for trees is too deep, fill hole with native soil only where applicable or prepared soil to correct levels.
- B. Set plants plumb and faced for best appearance.
- C. Remove wire baskets, burlap, fasteners from rootball completely if rootball will not be damaged. If damage is suspected, notify the DEPARTMENT for concurrence and remove tops and sides of baskets minimum. Use bolt cutters on wire if necessary to remove wire baskets. Bending back not acceptable. Remove all burlap and twine from planting pit.
- D. Remove metal cans or plastic containers completely from rootball.
- E. Neatly cut off broken, girdling, or frayed roots and any root growth growing in a circular manner conforming to its container.

### 3.06 BACKFILLING - General

- A. Before mixing, clean topsoil of extraneous materials and other materials harmful or toxic to plant growth.
- B. Prepare planting backfill soil mix prior to backfilling. Stockpile on site or have pre-prepared batches available from off-site source which can be delivered in a manner that does not disrupt or delay planting operations.
- C. Planting backfill soil mix shall be as follows: 1/2 peat moss, 1/4 amended topsoil and 1/2 soil excavated from planting pit.
  - 1. For ericaceous (acid loving) plants, include peat moss as part of the backfill mix.
  - 2. The modified backfill mixture schedule for these plants shall be of the following ratio:
    - a. 3/4 peat moss and 1/4 soil excavated from planting pit.
- D. Backfill half of plant pit around rootball with backfill soil mix, carefully tamp soil around rootballs.
- E. Provide slow-release fertilizer tablets during backfill at the following rates: Locate plant tablets 1 inch from roots and at mid-depth. Space evenly around the plant.
  - 1 gallon shrub = 1 tablet

- 2 gallon shrub = 2 tablet
- 3 gallon shrub = 2 tablet
- 5 gallon shrub or tree = 3 tablets
- 15 gallon tree = 4 tablets
- 20-24-inch B&B tree = 6 tablets

- F. Add 3 ounces mycorrhizal inoculum per caliper-inch to backfill around trees. Add 3 tablespoons mycorrhizal inoculum per gallon planting size. Add 1 teaspoon mycorrhizal inoculum per ground cover plant.
- G. Complete backfilling, firming to surface grade.
- H. Form watering basin from site topsoil as shown on Drawings.
- I. Thoroughly hand water each plant and entire bed immediately after planting. Adjust rootball and soil as required if settlement of soil occurs.
- J. Remove plant tags and ribbons.

### 3.07 PLANTING TREES AND SHRUBS

- A. Set roots or rootball on layer of compacted planting soil backfill mix or native suitable topsoil from planting pit, plumb and in center of pit or trench with top of rootball at 1 inch above elevation of adjacent finished grade.
- B. Place additional planting soil backfill mix around base and sides of ball and eliminate voids and air pockets. When backfill is approximately 2/3 complete, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing final layer of backfill. Cut burlap from top of rootball and roll back to sides of planting hole; form watering basin; stake and guy immediately after planting.
- C. After planting, apply top-dress fertilizer at the following rates:
  - 0-1 foot tall shrub = 0.4 oz.
  - 1-2 foot tall shrub = 0.8 oz.
  - 2-4 foot tall shrub or tree = 1.75 oz.
  - 4-8 foot tall shrub or tree = 4 oz.
  - 8+ feet = 4 oz. plus proportional amount per foot.

### 3.08 PLANTING GROUNDCOVER

- A. Space plants as shown or scheduled on Drawings. Dig holes 3 times the width and 1-1/2 times the depth of the rootball. Plant with planting soil backfill mix. Work soil around roots to eliminate air pockets. Water thoroughly after planting.
- B. After planting, apply top-dress fertilizer at the rate of 50 pounds per 1,000 square-feet, or apply 1 slow-release fertilizer tablet per plant during backfill.

### 3.09 ROOT CONTROL BARRIERS AT NEW PLANTINGS

- A. Provide linear and surround root barrier applications at trees within 5 feet of paving, curbs, walls, utility ducts or other appurtenances.
  - 1. For linear applications provide sufficient lengths of panels to equal mature width of tree canopy plus 2 feet, 10 feet minimum length. Provide on both sides of the tree trunk adjacent to curb and paving per manufacturer's recommendations.
  - 2. For surround applications provide a minimum of five 24-inch long panels where trees are planted on an individual basis. Shape connected panels to form an oval around the tree rootball.
- B. Excavate planting hole as specified for tree planting.

- C. Begin backfilling with soil mix and install tree as specified. Backfill up to depth equal to depth of root control barrier panel. Install interlocking root control panels around rootball, with minimum 8 inches clearance to rootball and with top 1/2 inch above finish grade.
- D. Backfill around rootball with planting soil backfill mix as specified for tree planting. Backfill outside of root control barriers with 3/4 to 1-1/2-inch crushed gravel, no fines (not pea gravel), to full depth of panels and minimum 4 inch wide area.

### 3.10 STAKING

- A. Deciduous Trees 1-inch caliper and larger: Provide 2 stakes per tree 180 degrees from each other in the direction of prevailing winds. Drive plumb outside of rootball as shown on Drawings. Place tree ties around tree trunk, approximately 4 feet from ground level, one from each side.
- B. Coniferous Trees 4 feet tall and larger: Provide 3 guys evenly spaced around trunk of tree. Set guys at a 60 degree angle to the trunk at 2/3 the height of the tree. Drive 2 by 2 inch wood stakes perpendicular to angle of cable. Secure guys taunt at trees passing each guy wire through a collar and setting the collar at the tree trunk where contact is made. Secure a warning flag on each cable as shown on Drawings.

### 3.11 MULCH

- A. Place mulch 3 inches deep in all planting beds. Rake smooth. Mulch shall be pulled away from crowns of shrubs, perennials and groundcover plants. Mulch shall be flush with adjacent curbs and paving. Taper mulch thickness from full 2-inches depth to 1-inch depth over a 12-inch horizontal run at paving edges so mulch will be flush with adjacent curbs and paving.
- B. Tree Plantings in Lawns:
  - 1. Deciduous Trees: Cut away and remove turf to establish a 4-foot radius circle from center of tree. Cut clean edge and fill with mulch.
  - 2. Coniferous Trees: Cut away and remove turf to establish a circular ring 2 feet beyond the outside dimension of drip line of tree. Ring to be centered on tree minimum 4-foot radius. Cut clean edge and fill with mulch.
  - 3. For trees in pavement cut outs, provide minimum 3 inches depth of mulch.
- C. Ground Cover Plantings:
  - 1. After fertilizing, mulch areas between groundcover plants; place minimum 2-inch thick specified mulch.

### 3.12 PRUNING

- A. Prune plant material if necessary and as directed by the DEPARTMENT to balance root and top growth. Prune, thin, and shape trees and shrubs in accordance with standard horticultural practices.
- B. Prune all dead and broken limbs.
- C. Prune without distorting basic form of plant and only to the extent necessary for each plant except where directed by the DEPARTMENT. Do not prune plants into boxes or balls.

### 3.13 MAINTENANCE

- A. Begin plant maintenance immediately after planting and continue until the end of the Maintenance Period or through any extensions of the Maintenance Period due to failure to supply written documentation of Punch List completion. Refer to Division 32 Section "Establishment Maintenance" for specific requirements.
- B. Hand-water plant material as indicated on Drawings for a period of 2-years.

### 3.14 CLEAN-UP AND PROTECTION

- A. During landscape work, keep pavements clean and work area in an orderly condition.

- B. Sweep and wash paved surfaces to remove soil and soil stains.
- C. Clean all mud and debris from catch basins, which is caused by Work of this Section.
- D. Remove plant containers, trimmings, clippings, and all extraneous debris unearthed or resulting from any operations specified herein, from Project Site and dispose in a lawful manner.
- E. Protect landscape work and materials from damage.
- F. Maintain protection during installation and Maintenance Period.
- G. Treat, repair or replace damaged Work as directed by the DEPARTMENT, at no additional cost to the Owner.

**END OF SECTION**

**SECTION 329500**  
**ESTABLISHMENT MAINTENANCE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Work of this section includes all labor, materials, equipment and operations to maintain all installed work as specified herein and as noted on the Drawings.
  - 1. Maintenance of all installed work for 2 years from the date of Substantial Completion.
- B. Related Documents:

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

**1.03 OWNER'S RESPONSIBILITY**

- A. Water: Owner will pay for water used for irrigation after the date of Substantial Completion.

**1.04 SUBMITTALS**

- A. Submit product Data and certificates showing compliance with EPA where applicable for the following:
  - 1. Fertilizers, including application rates.
  - 2. Herbicides, including application rates
  - 3. Pesticides, including application rates.
- B. Submit a Maintenance Schedule indicating frequency and type of maintenance work to be performed at each visit for the duration of the Maintenance Contract complying with the requirements of this Section.
- C. Submit a Weed and Pest Control Plan for approval at least 30 days prior to Substantial Completion of the Work.
- D. Submit a copy of the maintenance log at two-week intervals for the duration of the Project. Format of such log shall be established with the DEPARTMENT. At a minimum it shall include date and time of service, service duration, tasks performed, crew size, relevant notes on plant condition, and recommendations for supplemental corrective measures.

**1.05 ESTABLISHMENT AND WARRANTY PERIOD REQUIREMENTS**

- A. All plant materials shall be maintained in a healthy condition until the end of the Establishment, Maintenance and Warranty Period. Replace dead and unhealthy plants immediately.
- B. All plant materials and equipment replaced under warranty shall be replaced in accordance with all provisions of the Contract Documents. Equipment shall be of the same manufacturer, model, size and quantity as originally installed. Plant material shall be of the same variety, size, and quantity as originally installed.
  - 1. Owner reserves the right to inspect plant materials replaced under warranty and reject those which do not conform to specified standards.
- C. Schedule included in this Section indicates task minimums. CONTRACTOR may perform tasks at greater frequency to comply with Contract requirements.

**1.06 WEED and PEST CONTROL PLAN**

- A. CONTRACTOR shall submit a Weed and Pest Control Plan for approval at least 30 days prior to Substantial Completion of the work.
  - 1. The Weed and Pest Control Plan shall define all scheduled applications of herbicides and pesticides as required herein. It shall identify the applicator and license number, the names

- of the herbicide and pesticide products, along with the location, rate, frequency, season and method of application.
2. The CONTRACTOR may submit for pre-approval the use of herbicides and pesticides to be applied on an as needed basis in anticipation of probable weed growth or infestations.
  3. No herbicides or pesticides shall be applied until Weed and Pest Control Plan is approved and all applications shall be in accordance with the plan.
  4. If unanticipated weed growth or infestations occur, the CONTRACTOR shall be required to modify Weed and Pest Control Plan and secure written approval of Owner and DEPARTMENT prior to application.
  5. The Owner and DEPARTMENT shall review and approve the plan.
- B. All applications of herbicides and pesticides shall be performed by an Alaska State licensed commercial applicator. All precautions shall be taken in the handling and applications of all herbicides and pesticides as stated on the product label and in the Pacific Northwest Weed Control Handbook, latest edition. No contamination of vicinity water systems or storm drain systems allowed. No cleaning of equipment or disposal of products allowed in project vicinity.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. All products shall be as specified in the appropriate Specification Sections.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. Inspection: All grounds will be inspected weekly throughout the maintenance period for weeds, pests, plant health, erosion, paper, litter and debris.
- B. Pest and Disease Control:
1. Inspect all plants for signs of pest or disease once per week during the growing season and report any such conditions in the bi-weekly log report.
  2. Begin treatment for pests or diseases immediately following observation.
  3. Pest and disease control shall be carried out by skilled operators, using methods approved under current laws and regulations.
  4. Use the recommended type of equipment and method of application for each chemical as recommended by the chemical manufacturer.
  5. All chemicals shall be mixed and applied as stated on the label of the manufacturer.
  6. Be extremely cautious in the mixing, handling and application of all chemicals as they may be harmful (if misused) to humans, plants, and animals.
  7. The CONTRACTOR shall be liable for any damage caused through the misuse of any plant disease or plant insect control method.
  8. Rodent Control: The CONTRACTOR shall take the necessary action to prevent damage by rodents and moles. Such damage that does occur shall be repaired by the CONTRACTOR.
- C. Watering:
1. A manual irrigation system will be installed on this Project. The CONTRACTOR shall ensure that the irrigation system is in an operating condition throughout the period of this Contract.
  2. Coordinate and manage the irrigation so that appropriate amounts of water are applied based on season, weather condition and plant material.
  3. Drain the irrigation system at the end of the season.

### **3.02 LAWN AREA OPERATIONS**

- A. Fine Mowing:
1. For all Lawn areas the CONTRACTOR shall inspect and police the grounds for litter and debris prior to each mowing, and dispose of it.

2. All lawn is to be mowed every 7 days beginning in mid-April and through the end of September, with an additional two mowings in October, November, and March as needed.
  3. Mowing height for all irrigated lawn areas shall be no less than 1-1/2 inches, not to exceed 2-1/2 inches between mowing operations.
  4. The lawn shall be cut at a uniform height, with reel mowers in open areas and rotaries in closed areas. Scalping and uneven cutting shall be prevented. Any excess clippings shall be dispersed and/or collected to prevent damage to existing lawn areas or if it causes an unsightly appearance.
  5. Mower blades shall be maintained in a good condition for an even cut. Mower blades shall be cleaned prior to entering site to prevent dispersal of weed seeds picked up from off site.
  6. CONTRACTOR shall repair or replace all trees, shrubs and other plantings and other permanent fixtures that are damaged during mowing operations. Mowing equipment will be adjusted and maintained to provide the best possible cut.
- B. Edging: All sidewalks, curb lines, concrete slabs, bed edges shall be edged as needed to maintain a neat, clean appearance, once every three mowings (minimum).
- C. Hand Trimming: Trimming shall be performed around all road signs, fence posts, trees, shrubs, utility poles, sculpture bases, and other obstacles. The grass to be trimmed shall be trimmed no less than the desired height of cut determined by the mowing operation. Trimming is to be done with each mowing operation.
- D. Lawn Fertilization:
1. Fertilizing and Liming: Perform as recommended in the soil analysis reports submitted under Division 32 Section "Soil Preparation," and as necessary to maintain cover crop in a healthy growing condition.
  2. Application of fertilizers carried out by the CONTRACTOR to maintain proper nutrient levels and provide a consistent dark green lush appearance throughout the maintenance period. Lawn shall be fertilized a minimum of 1 time seasonally in spring and fall through the maintenance period. Spring fertilization should apply 8 pounds of nitrogen per 1,000 square feet, to maintain a consistent, lush green appearance. Fall fertilization should reduce nitrogen application to no more than 1 pound per 1,000 square feet.
  3. Deficiencies of sulfur or magnesium or other nutrients as determined by soil analysis shall be corrected as needed. Timing of these applications may vary according to the need for response.
- E. Weed Control:
1. Inspect Lawn areas for weed growth twice per month during the growing season and remove all weeds within one week of observing weed growth.
  2. Maintain all areas in a weed free condition.
  3. The application of herbicides on all mowed lawn areas shall be done according to the approved Pest and Weed Control Plan. One application with follow-up applications as required to maintain a kill of 90 percent of broadleaf weeds shall be required.
  4. Weed control procedures shall have no detrimental effect on the growth of desired plants.
- F. Re-Seeding: Upon detection of damaged or failing areas and areas showing unsatisfactory growth and coverage, the restore the area as necessary to establish a complete cover crop. Reseed using the seed mixes specified.
- G. Clean Walks: At the conclusion of each visit, walks adjacent to work areas are to be cleaned.
- H. Leaf Removal:
1. Removal of all leaves from all lawns, planting areas and walkways will be completed throughout the maintenance period as needed to maintain a clean appearance throughout the Project.
  2. Main entries, high traffic areas, and walkways shall be cleaned weekly. All other landscape areas are to have complete leaf removal monthly, during October, November and December.

- I. Aeration of Lawn Areas: Aeration is an extra service, to be performed as needed with Owner's authorization.

### 3.03 PLANTING AREAS

- A. Fertilizing:
  1. Fertilizing and Liming: Perform as recommended in the Soil Analysis reports and recommendations, and as necessary to maintain cover crop in a healthy growing condition. See Division 32 Section "Soil Preparation."
  2. Fertilizing of all trees, shrubs and ground cover is to be done once at the end of the maintenance period. Work the fertilizer thoroughly into the top 2 inches of soil.
  3. In late April or early May, after the danger of frost has past and within the first growing season, fertilize all planting areas with one (1) application of each of the following fertilizers, all at the rate of 7 pounds per 1000 square feet of soil surface:
    - a. Nitroform slow release (38-0-0)
    - b. Treble superphosphate (0-45-0)
    - c. Sulphate of potash (0-0-50)
- B. Weed Control:
  1. All planting areas, tree circles, sidewalk cracks, and pavers, are to be sprayed once per month to control unwanted grasses and broadleaf weeds according to approved Pest Control Plan. Chemical practices shall not be a substitute for hand-weeding where the latter is required for complete removal.
  2. All planting areas are to have one application of pre-emergence herbicide at the end of the maintenance period. Use of pre-emergence herbicides shall be pre approved by the DEPARTMENT and be of the non-leaching type, with minimal soil contaminating levels. Pre-emergence herbicides shall not be used in groundcover areas unless approved by the DEPARTMENT.
- C. Pruning: done to enhance natural growth. The CONTRACTOR shall remove dead, damaged and diseased portions of the plant. Do not remove collar at the branch base when pruning. All major pruning shall be done following flowering or during plant's dormant season. Emergency or minor pruning shall be done when needed. Pruning of trees shall be performed by a certified arborist.
  1. Shearing of plantings will be permitted only where directed by the DEPARTMENT.
  2. Provide remedial attention and repair to shrubs and trees as appropriate by season or in response to incidental damage.
  3. Prune shrubbery to maintain proper size in relationship to adjacent planting and intended function.
  4. Prune trees as required to remove weak branching patterns and maintain balance of head growth development. Remove lower limbs when obstructing vehicular or pedestrian clearances.
  5. Prune groundcover plantings as required to restrain perimeter growth to within planting areas where adjacent to walks and curbs. Tip prune selected branchlets of low growing shrub or groundcover masses to maintain even overall heights and promote fullness.
  6. Spent blooms shall be removed from all flowering shrubs to promote better growth habit and flower production.
  7. Remove blades of ornamental grasses that lay over flat to the ground. Retain grasses that are able to support their own weight. In the early spring, tie-off ornamental grasses with jute twine or a grass blade at the base of the plant and cut evenly across 6 inches from the base of the plant. **Do not cut Juncus.**
- D. Raking: All planting areas will be raked through once per month to remove debris and promote an attractive fresh appearance.
- E. Mulching: Maintain a 3-inch depth of specified mulch over all shrub planting areas unless directed otherwise by the DEPARTMENT. Do not remulch groundcover areas.
- F. Tree Stakes:

1. Check ties every 4 months to ensure that they are not causing a depression in the bark. Loosen, repair or replace as required.
  2. Retain guy wires in good repair until the tree is strong enough to withstand strong winds. Check at end of maintenance period. Ensure that they do not cause a depression in the bark. Repair or replace as required.
- G. Cultivating:
1. In the spring, before beginning watering, cultivate the soil surface shallowly as necessary to ensure penetration of water and air into the soil. Repeat as necessary for weed control and soil permeability.
  2. Avoid cultivating into the root zone of plants, particularly shallow-rooted groundcovers.

### **3.04 IRRIGATION EQUIPMENT WARRANTY WORK AND OPERATION**

- A. Establish time and intervals of irrigation water application for each planting area and trees in lawn. Make changes when necessary to correspond to variable watering requirements for all planting areas.
- B. Perform necessary site visits and observations to maintain the proper amounts of moisture in soils to promote healthy and vigorous plant growth. Correct conditions of over or under-watering as may be determined by weekly observations during the irrigation season.
- C. System Winterization: Shut off and completely drain systems no later than October 1. Turn off all main supply valves; open all manual drain valves; air drain, and bleed valves on backflow prevention devices. Perform winterization prior to the specified dates in the event of earlier freezing weather.
- D. System Spring Start-up: Activate irrigation systems in late April to early May. CONTRACTOR shall be responsible for repairing damage caused by freezing at no additional cost to Owner. Operate and observe all portions of the system and perform necessary rebalancing, flushing, cleaning or other work required to re-establish proper irrigation functions.
  1. Test and certify backflow preventers prior to placing the irrigation system back in service.
    - a. Original copies of the certification shall be submitted to the Owner.
    - b. Backflow preventers shall be labeled with plastic laminated field history tag showing date and tester information.
- E. Repair and/or replacement for any work damaged or otherwise affected even by causes beyond CONTRACTOR's control shall be the responsibility of the CONTRACTOR.
- F. Repair trench backfill which settles more than 1 inch during the Irrigation Warranty period. Warranty to include repair of planting areas, lawns, paving and walks damaged by settlement.

**END OF SECTION**

**SECTION 33 11 13  
WATER PIPE**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing buried water pipe and fittings, connecting to existing ductile iron water pipe, thrust blocks, tie rods, electrical continuity, disinfection and testing. The CONTRACTOR shall install the water pipe and fittings to the horizontal and vertical alignment shown on the Drawings and shall complete all associated WORK described in this Section.

**1.03 SUBMITTALS**

- A. Ductile Iron Water Pipe, Fittings, Joints and Bends: Material certifications stating conformance with requirements of this section.

**PART 2 – PRODUCTS**

**2.01 PIPE**

- A. Water pipe shall be ductile-iron pipe (DIP) conforming to the requirements of AWWA C151, with cement mortar lining conforming to the requirements of AWWA C104. Standard Thickness Class 50 pipe shall be used unless otherwise shown on the Drawings. Water pipe shall have an exterior bituminous coating conforming to the requirements of AWWA C110. All water pipe shall be clearly marked with the manufacturer's name, type, class and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.

**2.02 JOINTS**

- A. Unless otherwise shown on the Drawings, or as specified below, pipe joints shall be push-on rubber gasket type conforming to the requirements of AWWA C111.
- B. Restrained joint water pipe shall be U.S. Pipe TR FLEX, U.S. Pipe field Loc Gasket, EBBA IRON "Mega-lug System," Griffin Snap Lock, Pacific State Lock Mechanical type, or approved equal. Restrained push-on joints for pipe shall be designed for a water working pressure of 250 psi and shall be capable of being deflected a minimum of 3° per joint, for pipe sizes through 18 inches, after assembly.

**2.03 FITTINGS**

- A. Fittings for all water pipe and restrained joint water pipe shall be U.S. Pipe TR FLEX, push-on gasket fittings compatible with U.S. Pipe Field Loc Gasket, mechanical joint fittings with EBBA IRON "Mega-lug System" Griffin Snap Lock, Pacific State Lock Mechanical Type, or approved equal.

- B. For connecting to existing water mains, the CONTRACTOR shall use a mechanical joint tee and a mechanical joint cutting-in-sleeve similar to Clow F-1220 or Mueller H-843, or a cast iron coupling similar to Rockwell 431, or approved equal. The length of all sleeves and couplings shall equal or exceed the diameter of the pipe.
- C. All valve clusters consisting of a tee and one or more valves, including fire hydrant legs, shall be monolithically restrained with EBBA Iron "Mega-lug System," or approved equal.

#### **2.04 THAW WIRE**

- A. Thaw wire and continuity straps shall be No. 2 copper wire, stranded, with THW insulation or equal. Exothermic welding to attach continuity straps on DIP and fittings shall be "Cadweld" or approved equal and coated with bituminous coating.

#### **2.05 UNDERGROUND MARKING TAPE**

- A. Underground marking tape shall be blue, six inch wide, four mil thick, polyethylene tape with black lettering with the following wording: "Caution: Waterline Buried Below." Marking tape shall be installed 12 inches above the top of all water pipe.

#### **2.06 STEEL STRAPS**

- A. Steel straps shall be stainless steel with minimum cross sectional area of at least 1/2 square inch per 4 cubic yards of concrete. Straps shall be located symmetrically around the perimeter of the pipe.

#### **2.07 CONCRETE**

- A. Concrete for thrust blocks shall conform to Section 321314 –Concrete Structures.

### **PART 3 – EXECUTION**

#### **3.01 GENERAL**

- A. The CONTRACTOR shall preserve and protect all existing utilities and other facilities including but not limited to: telephone, television, electrical, water and sewer utilities, surface or storm drainage, highway or street signs, mailboxes, and survey monuments. The CONTRACTOR shall immediately repair or replace utilities or other facilities damaged during construction. The CONTRACTOR shall support and protect any underground utility conduits, pipes, or service lines where they cross the trench.
- B. The CONTRACTOR shall give at least 24 hours notice to the CBJ Water and Wastewater Utility Divisions and the CBJ Engineering Department prior to:
  - 1. needing water or sewer main line locates;
  - 2. interruption of water service in any area; or
  - 3. use of water from any fire hydrant.

Any water service disruption shall be restored as soon as possible. The CONTRACTOR shall comply with the current policy on "Water and Sewer Line Locates" of the CBJ Public Works Department, Water and Wastewater Utilities Divisions. The CONTRACTOR shall notify all local radio stations and any customers who will be affected of a planned water service disruption.

### 3.02 INSTALLATION

- A. Water pipe shall be installed in accordance with the manufacturer's printed specifications and instructions, and in conformance with AWWA C151.
- B. The water pipe shall be handled carefully to prevent damage to the pipe, pipe lining, or coating. Water pipe and fittings shall be loaded and unloaded using hoists and slings to avoid shock or damage, and under no circumstances shall they be dropped, skidded, or rolled. If any part of the coating or lining is damaged, repair thereof shall be made in a manner satisfactory to the DEPARTMENT at the CONTRACTOR's expense.
- C. All water pipe and fittings shall be inspected for defects. Damaged pipe will be rejected and the CONTRACTOR shall immediately place all damaged pipe apart from the undamaged and shall remove the damaged pipe from the site within 24 hours.
- D. Whenever it becomes necessary to cut a length of water pipe, the cut shall be made by abrasive saw or by special pipe cutter.
- E. All pipe ends shall be square with the longitudinal axis of the water pipe and shall be reamed and smoothed to ensure a good connection.
- F. The water pipe shall be laid to the horizontal and vertical alignment shown on the Drawings. A minimum five foot cover shall be maintained from finish grade to top of water pipe, unless otherwise shown on the Drawings. Fittings shall be installed at the location shown on the Drawings.
- G. To prevent dirt and other foreign material from entering the pipe and fittings during handling and installation, the open end of the pipe shall be protected by a water-tight plug at all times except when joining the next section of pipe.
- H. Under no circumstances shall pipe deflections, either horizontal or vertical, exceed the manufacturer's printed recommendations. Where deflections would exceed the manufacturer's recommendations, fittings shall be used.
- I. Vertical deflections to avoid obstructions that exceed allowable water pipe joint deflections shall be accomplished by the use of fittings and either joint restraints or vertical thrust blocking conforming to the Drawings. Additional fittings to those indicated on the Drawings will be required to accomplish these vertical deflections.
- J. Concrete thrust blocks shall be furnished and installed in accordance with the Drawings.
- K. Pressurized water pipe ends shall be plugged and thrust blocks installed. Volume and bearing area of thrust blocks for end plugs shall be equal to applicable standards for bends greater than 45°.
- L. Existing water pipes and appurtenances to be removed or abandoned shall be as designated on the Drawings or directed by the DEPARTMENT. Abandoned water services shall be plugged at the cut ends. Abandoned water pipes shall be removed as shown on the Drawings, or mechanically plugged if not required to be removed.
- M. All pipe fittings shall be restrained with EBBA Iron "Megalug System," or approved equal.
- N. All joints within 50 feet of tees or bends equal to or greater than 45° shall be restrained joints.

- O. Continuous water services shall be provided for all structures, except for interruptions necessary for connection of temporary or new piping to the existing service or mainline piping.
- P. The CONTRACTOR is responsible for maintaining continuous water service at volume and pressure to match existing to all structures, with either existing, temporary or new piping, except as provided in this Section.

### **3.03 FLUSHING, TESTING AND DISINFECTION**

- A. Prior to acceptance, the CONTRACTOR shall "Open-Bore" flush the water pipe then perform hydrostatic tests, electrical continuity tests, and disinfection and coliform tests. Testing may be done in any sequence. However, in the event the disinfection, coliform and continuity tests have been performed and repairs are made to the water pipe system in order to pass the hydrostatic test, all previous tests and the "Open-Bore" flushing shall be repeated to the satisfaction of the DEPARTMENT.

### **3.04 OPEN-BORE FLUSHING**

- A. Open bore flushing is required of all installed water pipes to remove any foreign matter. The CONTRACTOR shall furnish, install and remove all pumps, fittings and pipes necessary to perform the flushing; shall provide all additional excavation and backfill; and shall dispose of all water and debris flushed from the water pipe. Flushing through fire hydrants, reduced outlets or fittings shall not be permitted unless specifically authorized in writing by the DEPARTMENT. The CONTRACTOR shall notify the DEPARTMENT, in writing, 48 hours in advance of any flushing operation. All flushing shall be done between the hours of 1:00 a.m., and 5:00 a.m., unless otherwise authorized by the DEPARTMENT. A flushing scheme and schedule shall be submitted by the CONTRACTOR for review and approval by the DEPARTMENT prior to flushing. The schedule for flushing must be approved by the CBJ Water Utility Division. The CONTRACTOR shall be responsible for obtaining any permits necessary for flushing operations.

### **3.05 HYDROSTATIC TESTING**

- A. Hydrostatic testing will be conducted in the presence of the DEPARTMENT on newly installed water pipes after "Open-Bore" flushing, in accordance with the requirements of AWWA C600 and as stated hereafter. The CONTRACTOR shall furnish all assistance, equipment, labor, materials, and supplies necessary to complete the test to the satisfaction of the DEPARTMENT. The CONTRACTOR shall suitably valve-off or plug the outlet to existing or previously-tested water pipe prior to performing the required hydrostatic test. Prior to testing, all air shall be expelled from the water pipe. If permanent air vents are not available to accommodate testing, the CONTRACTOR shall install corporation stops and blow-off lines so the air can be expelled as the line is filled with water.
- B. Pressure Testing
  - 1. The hydrostatic pressure for main line pipe shall be a minimum of 150 psi or 1½ times the operating pressure of the water pipe (measured at the highest elevation of the newly-installed water pipe), whichever is greater, unless otherwise directed by the DEPARTMENT. Acceptance pressure testing shall be done with all service lines installed, corporation stops open, and pressure against the closed curb stops. The duration of each hydrostatic pressure test on main line pipe shall

be one hour. Pumping will cease after the required test pressure has been reached. If the pressure remains constant for one hour without additional pumping, or pressure drop is less than five psi, that section of water pipe is acceptable.

2. The hydrostatic pressure for fire line testing shall be a minimum of 200 psi for two (2) hours as defined by National Fire Protection Association (NFPA) 24. Acceptance pressure testing shall be done with all service lines installed, corporation stops open, and pressure against the closed curb stops. Pumping will cease after the required test pressure has been reached. If the pressure remains constant for two hours without additional pumping, or pressure drop is less than five psi, that section of water pipe is acceptable.
- C. If the pressure drops five (5) psi or more during the initial one hour hydrostatic pressure test, the CONTRACTOR shall conduct a leakage test. Leakage shall be determined by measuring "make-up" water necessary to restore the specified test pressure. The quantity of water lost from the water pipe shall not exceed the number of gallons per hour as determined by the following formula:

$$L = \frac{ND(P)^{0.5}}{7400}$$

L = Allowable leakage in gallons per hour

N = Summation of mechanical and push-on joints in length of water pipe tested

D = Diameter of water pipe in inches

P = Test pressure in pounds per square inch

- D. Should the tested section fail to meet the pressure test as specified, the CONTRACTOR shall locate and repair the defects and then retest the water pipe as specified above. Any specific leakage point detected shall be corrected by the CONTRACTOR to the satisfaction of the DEPARTMENT regardless of the allowable leakage specified above.
- E. All tests shall be made with the auxiliary gate valves open and pressure against the hydrant. After the hydrostatic test has been successfully completed, each valve shall be tested by closing in turn and relieving the pressure beyond. This test of the valves will be acceptable if there is no immediate loss of pressure on the gauge when the pressure comes against the valve being checked. The CONTRACTOR shall verify that the pressure differential across the valve does not exceed the rated working pressure of the valve.
- F. Sections to be tested shall be limited to 1,500 feet, unless otherwise approved in writing by the DEPARTMENT.
- G. Defective materials or poor quality of WORK, discovered as a result of the hydrostatic tests, shall be replaced by the CONTRACTOR. Whenever it is necessary to replace defective material or correct the workmanship, the hydrostatic test shall be repeated until a satisfactory test is obtained.
- H. The DEPARTMENT shall be present for all hydrostatic and leakage tests. The CONTRACTOR shall notify the DEPARTMENT at least 24 hours prior to any test and shall notify the DEPARTMENT at least two hours in advance of the scheduled time if the test is to be cancelled or postponed.
- I. After completion of testing, all test and air vent pipe shall be removed and the corporation stop closed at the water pipe, in the presence of the DEPARTMENT.

### 3.06 ELECTRICAL CONTINUITY

- A. Electrical continuity is required for six inch or smaller water pipe and fire hydrant assemblies, and shall be provided by two electrical continuity straps installed on each side of the water pipe joint or fittings. Electrical continuity tests will be performed by the CBJ Water Utility Division staff with a "Hovey" water pipe thawing machine, unless scheduling conflicts or mechanical problems with the thawing machine prevent the CBJ Water Utility Division staff from performing the testing within the time period required by the CONTRACTOR. In those cases that the CBJ Water Utility Division staff is unable to conduct the testing, the CONTRACTOR shall conduct the testing with its own personnel and equipment. The testing shall be performed in a manner that is approved by the DEPARTMENT. All resilient gate valves 6 inch and smaller are required to have a thaw wire either bolted or cad welded to the valve body, and raised through the inside of the of the valve box, therefore making it available for both continuity testing and thawing. An additional thaw wire will still need to be attached to the main and coiled around the outside of the box according to current CBJ Standards.

If the initial testing of an installation fails (the continuity testing will be conducted by the CBJ), the additional testing required shall be at the CONTRACTOR's expense. The CBJ Water Utility Division staff will maintain a circuit of 300 amps DC current for a period of 90 seconds. Current loss, through the test circuit, shall not exceed 10%. Continuity test sections shall not exceed 500 lineal feet. All test leads brought up to the surface shall be removed to a depth of two feet below finish grade upon completion of the tests.

### 3.07 DISINFECTION

- A. Disinfection by chlorination of all new water pipe shall be completed and a satisfactory bacteriological report obtained prior to placing the pipe in service. "Open-bore" flushing shall be completed before chlorination is begun.
- B. Chlorine shall be applied by one of the following methods:
1. liquid chlorine gas-water mixture;
  2. direct chlorine gas feed; or
  3. hypochlorite commercial products such as HTH, Perchlolen, Macho-chlor, or approved equal.

The chlorinating agent shall be applied at the beginning of the section adjacent to the feeder connection, insuring treatment of the entire water pipe. Water shall be fed slowly into the new water pipe with chlorine applied in amounts to produce a dosage of 50 ppm. Application of the chlorine solution shall continue until the required residual of not less than 50 ppm free chlorine is evident at all extremities of the newly constructed line.

- C. The chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device. Chlorine gas shall be fed directly from a chlorine cylinder equipped with a suitable device for regulating the rate of flow and the effective diffusion of gas within the water pipe. Hypochlorite products shall be placed or injected into the water pipe. During the chlorination process, all intermediate valves and accessories shall be operated. Valves shall be manipulated so that the strong chlorine solution in the water pipe being treated will not flow back into the pipe supplying the water.

- D. The following table is to be used as a guide for chlorinating pipes by the calcium hypochlorite and water mixture method. The given dosage per 100 feet results in a chlorine solution of 40 to 50 ppm. This dosage takes into account that CONTRACTOR's most frequently use granular HTH, which is 65% pure. If another chlorinating agent is used, the dosage must be adjusted.

PIPE DIAMETER	DOSAGE PER 100 FEET
6"	1.35 oz.

- E. A residual of not less than 50 ppm free chlorine shall be produced in all parts of the water pipe. After 24 hours detention there shall be a minimum free chlorine residual of 25 ppm in all parts of the water pipe. This residual shall then be neutralized in the pipe by injecting an approved reducing agent such as sulfur dioxide, sodium bisulfate, sodium sulfite or sodium thiosulfate.
- F. After the water pipe system has been thoroughly flushed, samples will be taken at representative locations in the system by the DEPARTMENT, placed in sterile bottles, and submitted to an approved laboratory for bacteriological examination. The presence of bacteria in any sample shall be verified with a second sample at the same location. If verified, the pipe disinfection procedure shall be repeated and additional samples taken for bacteriological examination. Pipe disinfection shall be repeated, at the CONTRACTOR's expense, until satisfactory results are obtained. The first testing sequence will be paid for by the OWNER. Any further testing and sampling required due to insufficient disinfection (positive coliform tests) will be paid for by the CONTRACTOR.
- G. The water shall be flushed from the water pipe at its extremities, including all curb stops, until the replacement water chlorine residuals are equal to those of the permanent source of supply. The de-chlorinated water and water used for flushing shall be disposed of in a manner approved by the DEPARTMENT and in conformance with current requirements of the Alaska Department of Fish and Game and the Alaska Department of Environmental Conservation.

**END OF SECTION**

**SECTION 33 11 17  
PIPE INSULATION**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing pipe insulation for water pipe and service pipe at locations shown on the Drawings and as directed by the DEPARTMENT.

**PART 2 – PRODUCTS**

**2.01 RIGID INSULATION**

- A. Rigid insulation shall be rigid board closed cell polystyrofoam material containing a flame retardant additive specifically designed for underground pipe or pavement installations, equivalent to Dow Chemical Company Styrofoam HI, and approved by the DEPARTMENT.

**2.02 SPRAYED-ON INSULATION**

- A. Sprayed-on urethane foam insulation applied directly to the pipe exterior with an elastomeric coating, may be approved by the DEPARTMENT, provided the material has demonstrated a satisfactory performance history in underground installation and has the following physical properties:

Density	2 pcf, Minimum
Compressive Strength (ASTM D 1621)	35 psi, Minimum at 5% Deflective or Yield
Water Absorption (ASTM C 177)	0.25% by Vol. Maximum
Thermal Conductivity (ASTM C 177) Hr.Ft. <sup>2</sup> EF.In. Thickness	<u>Max. 0.23 BTU</u>

**PART 3 – EXECUTION**

**3.01 CONSTRUCTION**

- A. When water pipes or service pipes have less than 5-feet of cover to finished grade or vertical clearance at a storm drain culvert crossing, either above or below, they shall be insulated as shown on the Drawings.

- B. Rigid insulation shall be a minimum of 2-feet wide and 2-inches thick. The length of insulation required shall be as shown on the Drawings or as directed by the DEPARTMENT. Insulation shall be placed between 6 and 12-inches from the water pipe or service pipe with the width centered on the longitudinal axis of the water pipe or service pipe as shown on the Drawings.
  
- C. Sprayed-on urethane foam insulation shall be a minimum of 4-inches thick and be installed in strict conformance to the manufacturer's recommendations. Precautions to protect CONTRACTOR personnel, Project inspectors, and the public in general shall be taken by the CONTRACTOR in compliance with OSHA Standards and the manufacturer's recommendations.

**END OF SECTION**

**SECTION 33 22 00  
PRODUCTION WELL**

**PART 1 GENERAL**

1.01 The Contractor shall provide all equipment, materials, labor and plant to furnish and install production wells. The work for each well shall include but not necessarily be limited to: construction of a production well; driller's well log; aquifer sampling, well development; well testing; well decommissioning, if required; and any other work required by the contract documents to provide complete well facilities.

A maximum of two wells will be constructed (refer also to the Production Well Site Plan).

Except as otherwise specified, work including ordering of materials, shall not begin on a production well until all pre-construction submittals for the production well have been submitted and approved.

After drilling a production well, and prior to ordering the well screens, the Contractor shall allow maximum of two weeks for the Department to perform the following tasks:

- gamma-log the well
- perform sieve analyses on aquifer samples, and make a recommendation for the well screens (screen location(s), slot sizes, and lengths).

No additional payment, will be made for the pause in the Contractor's work due to the above mentioned two-week period.

If the drilling fluid is air, the Contractor shall install the casing to the bottom of the hole prior to the above mentioned two-week period for Department tasks. If the drilling fluid is mud, the two-week period shall commence once the well has been drilled to the required depth, and the Contractor shall not install the well casing until the gamma-log has been completed.

If a production well is not successful (e.g. insufficient water bearing aquifer, or presence of shallow bedrock), the well will be decommissioned.

1.02 Standards

- A. ANSI/AWWA A100-06 (Revision of ANSI/AWWA A100-97); effective date August 1, 2006.

1.03 Related Sections

- A. 01 33 00 Submittal Procedures

1.04 Desired Production Rates

- A. Production Well (10" diameter)
  - 1. Design Production Rate 300 gpm
  - 2. Well Development Flow Rate 1200 gpm
  - 3. Well Testing Flow Rate 1200 gpm  
(well pump performance testing)

1.05 Submittals

- A. Refer also to Section 01 33 00 Submittal Procedures.

Submittals for the production well shall include, but not be limited to:

Pre-construction submittals for the production well

1. A work schedule.
2. Drilling fluid(s).
3. Well casing including welder qualifications and screen supplier welding recommendations.
4. Aquifer sampling plans (method, frequency and size of samples).
5. Well screens, including the screen sump and bottom seal, and the screen riser and packer. This submittal is not required until after the Department provides a well screen recommendation (refer to section 1.01).
6. Plan for installing the well screen.
7. Grouting and sealing materials.
8. Proposed screen to casing joint type.
9. Proposed screen to screen joint type.
10. A plan for well development and well testing. Describe methods to be used, and submit data sheets for measuring devices (water flowrate, well water levels, sand measurement, equipment to be used for flow control, observation well water levels, etc.).
11. Pump data including pump curves for pump(s) that will be used for well development and well testing.
12. Headloss calculations for well development and well testing pump / piping systems.
13. A piping plan for delivering well discharge water to the designated discharge point, including pipe materials, sizes and pipe joint types.
14. Plan for achieving the required plumbness and alignment of the well casing.

Post-construction submittals for the production well

1. Driller's Log.
  2. Well development records which shall include:
    - Development method(s) utilized
    - Duration of methods
    - Visual observations of water quality
  3. Well test report (to be provided by the Department's representative)
- B. The Contractor shall submit detailed data sheets for all materials and products requiring a submittal. Plans and reports shall also provide detailed information.

PART 2 MATERIALS

2.01 Drilling Fluids

- A. Drilling fluids shall be per ANSI/AWWA A100-06 Section 4.3.1 Drilling Fluid Materials. Drilling fluids shall meet NSF 60 standards.

2.02 Well Casing Casing

- A. Well Casing

1. Except as otherwise specified, all casing materials shall be new single-ply carbon steel and shall conform to one of the manufacturing standards outlined in ANSI/AWWA A100-06 Table 2. A., Manufacturing standards for single-ply carbon-steel well casing. A manufacturer's certification of materials shall be provided by the Contractor.
2. Minimum casing thickness shall be 0.50 inches.
3. Minimum casing inside diameter shall be as specified in the bid schedule.

## 2.03 Screens

### A. Schedule for Screen Selection

1. Screens shall be ordered by the Contractor after:
  - Aquifer sample sieve analyses, prepared from samples taken from the production well hole, have been completed
  - Gamma-log has been completed
  - Well casing data sheet, specifically including the inside diameter of the casing, has been submitted to the well screen supplier.
  - the Department in coordination with the Engineer of Record have selected the screen locations, slot sizes and lengths.

### B. Screen Locations:

1. The screen locations shall be provided by the Department in coordination with the Engineer of Record prior to ordering the screens.

### C. Screen Aperture Size:

1. The screen aperture (slot) size shall be one slot size smaller than the size selected per ANSI/AWWA A100-06 4.5.5 Screen Aperture Size (e.g. if the normally selected slot size is 20 (Johnson Screen slot size), the required slot size will be 15). The screen aperture size shall be provided by the Department in coordination with the Engineer of Record prior to ordering the screens.

### D. Screen Length:

1. Final screen length, excluding the riser, shall be sized based on the screen aperture size and the specified screen entrance velocities. The maximum screen entrance velocity shall be 0.1 feet per second. The screen riser shall not be included in the screen length calculation. The screen lengths shall be provided by the Department in coordination with the Engineer of Record prior to ordering the screens.

### E. Screen Sump:

1. Provide a 2-foot long screen sump.
2. The sump materials shall be the same as the screens.

### F. Bottom of Screen Seal

1. The bottom of the screen seal shall be a threaded, or welded steel plate constructed of the same materials as for the well screen or screen sump, as applicable.

2. Optionally, the Contractor may use a self-closing valve, if required to remove mud in the bottom of the well. Once removal of the mud is complete, the valve shall be covered by a concrete plug as least 1.0 foot in depth.

G. Screen Construction, Materials, Manufacturer

1. All screen materials shall be new.
2. The Contractor shall coordinate screen design with the screen manufacturer and shall provide well casing dimensions, including the inside dimension, to the manufacturer.
3. Screen, screen riser and packer, shall be as manufactured by Johnson Screens, or approved alternative. The screen shall be a Johnson Screens Hi-Flow 8" P (8-inch pipe size) suitable for a 1000-foot well depth, or approved alternative.
4. Screen materials shall be 316L stainless steel.
5. Screen type shall be rod-based wire-wound continuous-slot screens per ANSI/AWWA 4.5.7.2.
6. Screens shall be the telescoping type.

H. Screen Riser

1. Screen riser construction, materials and manufacturer shall be the same as for the well screens, except that the screen aperture size shall be 10 slot.
2. The screen riser length shall be 3 feet, welded to the top of the screen. The riser shall remain inside the casing.

I. Packer

1. The packer be a 316L stainless steel, Figure K packer, to be welded to the top of the screen riser.

2.04 Grouting and Sealing Materials

- A. Except as otherwise specified, grouting and sealing materials shall be per the Alaska Department of Environmental Conservation (ADEC) requirements (refer to 80 AAC 80.015).
- B. Grouting material shall be bentonite clay.

PART 3 EXECUTION

3.01 Well Hole Depth

- A. Refer to the Bid Schedules for well hole depth.

3.02 Drilling Method

- A. The method of drilling for the production well shall be by rotary drill.

3.03 Drilling Fluids Properties

- A. Drilling fluid shall be at the option of the Contractor, except that the drilling fluid must meet all other requirements of this specification.
- B. During drilling operations, when additives to fresh water are used, drilling-fluid properties shall be maintained within limits that will allow their complete removal from water produced from the well, and shall not damage the potential capacity, efficiency, or quality of the well.

3.04 Aquifer Sampling and Sieve Analyses

- A. Sampling is the responsibility of the Contractor. Sieve analyses shall be provided by the Department's Representative.
- B. Samples taken from the bottom 50 feet of the production well, shall be taken using a 2.5-inch inside diameter split spoon casing. All split spoon samples shall be taken from undisturbed soil.
- C. Samples taken above the bottom 50 feet, shall be taken from drilling fluid returned from the well hole. Where drilling fluid is mud, the Contractor shall properly clean the samples to remove the mud.
- D. Formation samples shall be taken at maximum intervals of 10 feet beginning at the top of the hole, and at each change in formation. Particular care shall be taken when collecting samples from expected water producing zones.
- E. Samples shall be collected, dried and preserved in separate containers of at least 2.0 pound capacity for each interval. Containers shall be plainly marked with the well designation, Department name, project, project number, location, depth interval, sampling method, date, and time.
- F. Immediately after completing the well hole, the aquifer samples shall be shipped to a soils laboratory in Anchorage, Alaska (laboratory selected by the Department's Representative). Samples shall be safely stored until such time as they are delivered to the laboratory.
- G. Sieve analyses (by Department's Representative) shall be performed for all samples taken at, or within, the bottom 50 feet of the well hole. Sieve analyses shall provide sufficient information to allow for the screen aperture size determination per ANSI/AWWA A100-06, 4.5.5 Screen Aperture Size. Sufficient screens shall be utilized to cover the sand particle sizes (coarse through very fine) such that the  $D_{10}$ ,  $D_{60}$ , and uniformity coefficient of the sand portion of the samples can be accurately calculated.

3.05 Plumbness and Alignment

- A. Plumbness and alignment of the well casing shall be such that:
  - 1. A submersible pump/motor assembly and pump discharge piping can be freely installed in the casing and connected to a pitless adapter (adapter at top of casing), without stress or damage to the pump, discharge pipe, pitless adapter, or power cord; and without the pump or discharge piping having to be forced down the casing because of contact with the casing wall. The maximum outside diameter of the pump/motor assembly is expected to be 8 inches.

2. Telescopic screen (assume 50 foot maximum length) can be installed without damage, and without having to be forced down the casing due to contact with the casing wall.

### 3.06 Casing and Screen Installation

#### A. Well Casing and Screen

1. The method of well casing installation shall be at the option of the Contractor, provided the installation meets with the plumbness and alignment requirements, is completed per the screen manufacturer's recommendations, and the installation process does not alter the shape, size, configuration or strength of the casing or screens.
2. Casing joints shall be welded, or threaded and coupled, per ANSI/AWWA A100-06, Section 4.7, Table 6. The Contractor shall check each stick of pipe after welding to ensure that there are no weld slag protrusions, nor sharp burrs or edges, on the inside of the casing.
3. Screen to casing joints shall be welded or threaded and coupled, as recommended by the screen manufacturer.
4. Screen segment to screen segment joints, and screen segment to screen sump joints, shall be welded or threaded and coupled, as recommended by the screen manufacturer.
5. If the drilling fluid is air, the telescopic screen shall be installed by the pull-back method, which involves installing the well casing to the full depth of the well, lowering the well screen inside the casing, then pulling back or lifting the casing far enough to expose the screen.

If the drilling fluid is mud and the Contractor proposes to use mud to maintain an open borehole, the Contractor is not required to utilize the pull-back method to install the screen.

In either case, the screen riser and K-packer shall remain within the casing.

### 3.07 Grouting and Sealing

- A. Furnish and install a temporary outer surface casing to a minimum depth of 10 feet. The casing shall be withdrawn as the grout is placed.
- B. The well shall be sealed by a continuous seal from the ground surface to a depth of 10 feet below ground level.
- C. The annular space which shall be grouted around the casing shall be not less than 3 inches in radial thickness, or 6 inches in net diametrical difference.

### 3.08 Well Site Requirements

- A. At all times during the work the Contractor shall use reasonable precaution to prevent either tampering with the well, or the entrance of foreign material or surface water into the well.

- B. On completion of the well the Contractor shall install a suitable threaded, flanged, or compression fitting seal at the top of the casing.
- C. The top of the casing shall terminate at least two feet above the finished ground level.
- D. For a distance of at least 10 feet in all directions around the well casing, the surface must be sloped or contoured to slope away from the well at a minimum 3% grade. The ground elevation (finished ground level) at the well casing shall be a minimum of one foot above existing ground. The surface extending at least 2 feet in all directions around the well casing shall be impervious.

### 3.09 Coordination With the Department's Representative

- A. The Contractor shall coordinate with the Department's representative (hydrogeologist or other), and allow time as required, for performance of the following work (work by the Department):
  - Geotechnical logging of the production well hole (the Department's representative is not responsible for collecting samples, but only for preparing the log).
  - Gamma-log of the production well.
  - Monitoring the results of well development.
  - Working with the Contractor to develop a well pump testing program.
  - Supervising the gathering of data during well pump testing. The Contractor shall provide assistance, as required by the Department's Representative, for gathering data during the well pump test.
- B. The Contractor shall coordinate with the Department's Representative prior to and during well hole drilling, well development, and well pump testing to allow the Department's Representative to accomplish the following:
  - Obtain water samples during periods of drilling with air, or pumping water from the well. The Contractor shall provide a valved sampling point on the pump discharge pipe for that purpose. Water sampling and testing shall be by the Department.
  - Observe the water discharge for contamination.

If in the Department's judgment contamination is observed in water discharge, or in water contaminated by the Contractor's equipment, Contractor will be required to stop work and await direction from the Department.

### 3.10 Well Development and Well Testing

- A. Furnish and Install Well Development Pump, Well Testing Pump, Discharge Piping, and Appurtenances.

The Contractor shall furnish and install: power supply for pump operation; all pumps; water discharge pipe from the well to the specified discharge point; all measuring, monitoring and control devices, including orifices or other devices that will accurately measure the discharge rate. The discharge pipe shall be water tight, and of sufficient size for the specified water flow rate. The discharge piping shall also include a valve, or other appropriate device, that will vary the discharge rate. The flow measurement device to measure pump discharge rate shall have a minimum accuracy of 95%.

The well development and well testing equipment used shall permit variable pumping discharge rates.

The pump and prime mover shall have a capacity in excess of the required total dynamic head (TDH) at the required flow rates. The TDH calculations shall include an 80% drawdown in the well casing (e.g. if the distance from the well static water level to the bottom of the casing is 100 feet, drawdown shall be assumed to be 80 feet (100' times 0.8 = 80'). The Contractor shall provide headloss calculations to include all piping, fittings, valves, etc. from the pump to the designated discharge point.

B. Well Development

1. Prepare and submit well development records.
2. The preliminary method(s) of development of the well shall be at the Contractor's option, but shall be a commonly used technique(s). Following the use of one or more preliminary methods, a well pump shall be used for final development and testing.
3. The well shall be developed so that it will produce the specified well development flow rate (Item 1.04 Desired Production Rates).
4. Measurement of water level shall be by Air-Line Method or Electric-Sounder Method per ANSI/AWWA A100-06, Appendix E, Well Development; or an approved alternative.
5. Measure of sand content shall be per ANSI/AWWA A100-06, Appendix E, Well Development. Sand content shall average not more than 5 mg/L for a complete pumping cycle of 2-hr duration, when pumping at the specified well development flow rate.

6. Development Records

The following data shall be recorded in the work record:

- a. Static water levels
- b. Pumping water levels
- c. Recovery rate data
- d. Methods of measurement
- e. Duration of each operation
- f. Observation of results
- g. Sand content as a function of discharge rate and time
- h. A description of materials and equipment used for pumping and measurement.
- i. All other pertinent information

C. Well Testing

1. The Department's Representative shall supervise and monitor the pump test, collect pump test data, and prepare the test report.
2. A step-drawdown test shall be conducted. The well shall be pumped at a minimum of at least three progressively increasing rates, and the time length of each step shall be long enough to indicate a straight-line trend on a plot of

drawdown versus logarithm of time since pumping began. The final flow rate shall be the well testing flow rate (Item 1.04 Desired Production Rates).

In lieu of a step-drawdown test, the Department's representative may choose to perform a preliminary constant rate pump test.

3. Following the step-drawdown test, or the optional preliminary constant-rate pump test, a final constant-rate test shall be conducted. Prior to the final constant-rate test the well shall be allowed to recover to approximately static conditions. Following recovery, the final constant-rate flow test shall be conducted at the specified well testing flow rate (Item 1.04 Desired Production Rates). The well shall be pumped at a constant rate until a straight-line trend is observed on a plot of water level versus the logarithm of time since pumping began. The pump test shall continue for a minimum of 48 hrs to a maximum of 72 hrs.
4. Recovery time of the pumping well and any observation wells to be used in the test shall be such that a straight-line trend is observed in all of the wells on a plot of water level versus the logarithm of time since pumping stopped.
5. Water level measurement shall be obtained before, during and after each step of the step-drawdown test, or the preliminary constant rate pump test; and before, during and after the constant-rate test. The measurement frequency shall adequately define the drawdown trend and the recovery trend.
6. Measurement of water level shall be by Air-Line Method or Electric-Sounder Method per ANSI/AWWA A100-06, Appendix E, Well Development; or an approved alternative.
7. Observation Wells: An existing monitoring well on the project site (refer to drawing for location) shall be utilized as an observation well for all well pump tests including each step of the step-drawdown test, and the constant-rate test. The Contractor shall furnish and install all equipment for measuring the water level vs time in the observation well.

### 3.11 Decommissioning

- A. Wells shall be decommissioned per 18 AAC 80.015 (e) (1) of the Alaska Department of Environmental Conservation (ADEC) regulations, which states that decommissioning shall be accomplished by "a method that conforms to ANSI/AWWA Standard A100-97, Water Wells, and Appendix H to ANSI/AWWA Standard A100-97 (Decommissioning of Test Holes, Partially Completed Wells, and Abandoned Completed Wells...". Appendix H is attached to the end of this specification section.
- B. The wells shall be decommissioned using bentonite as the sealing material.
- C. After the well has been sealed, cut the casing off two feet below grade, or at an elevation as directed by the Department.
- D. Provide an as-built of the location of the well. Where possible, locate the well with swing ties to at least three permanent existing facilities.
- E. The well shall be decommissioned only if required by the Department.
- F. Decommissioning of the well shall not be done prior to approval from the Department.

### 3.12 Driller's Log

- A. During drilling and completion of the well, the Contractor shall maintain a complete log setting forth items required by ADEC regulations (refer to 18 AAC 80.210 (h)). The well log shall contain the follow information:
1. The method of construction
  2. The type of fluids used for drilling
  3. The location of the well
  4. An accurate log of the soil and rock formations encountered and the depth at which the formations occur
  5. The depth of the casing
  6. The height of the casing above ground
  7. The depth and type of grouting
  8. The depth of any screens
  9. The casing diameter
  10. The casing material
  11. The depth of perforation or opening in the casing
  12. The well development method
  13. The total depth of the well
  14. The depth of static water level
  15. The anticipated use of the well
  16. The maximum well yield
  17. The results of any well yield, aquifer, or drawdown test that was conducted
  18. The depth of pump intake and pump performance data, if a pump is installed at the time of construction.

The Contractor shall complete and submit the attached Alaska Department of Natural Resources (ADNR) water well driller's log form. The Contractor may utilize an alternative form, if it includes all the information required by the ADNR form.

**END OF SECTION**

**SECTION 33 31 13  
SANITARY SEWER PIPE**

**PART 1 - GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing sanitary sewer pipe, in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Drawings.
- B. This WORK includes furnishings and installing connecting bands, branch connections, elbows or other fittings, and all appurtenances required to complete the sanitary sewer and connect to existing sanitary sewer pipe and/or structures.

**1.03 SUBMITTALS**

- A. Sanitary Sewer Pipe: Material certifications stating conformance with the requirements of this Section.
- B. HDPE Force Main Pipe: Material Certifications stating conformance with the requirements of this Section.

**PART 2 - PRODUCTS**

**2.01 PVC SEWER PIPE**

- A. PVC Sewer Pipe, four inch through 15 inch in diameter, inclusive, shall have a standard dimension ratio (SDR) of 35, and conform to ASTM D 3034. Before any PVC pipe is used on this Project, the CONTRACTOR shall supply certifications, signed by an authorized agent of the seller or manufacturer, stating that the material has been sampled, tested, and inspected in accordance with ASTM D 3034.
- B. PVC Sewer Pipe greater than 15 inch in diameter shall conform to ASTM F 679. Before any PVC pipe is used, the CONTRACTOR shall supply certifications, signed by an authorized agent of the seller or manufacturer, stating that the material has been sampled, tested, and inspected in accordance with ASTM F 679.
- C. The pipe shall have integral wall bell and spigot joints conforming to ASTM D 3212. The bell shall consist of an integral wall section with a solid cross-section elastomeric ring, factory assembled, securely locked in place to prevent displacement.
- D. Flexible water-tight connections, approved by the DEPARTMENT, shall be used at PVC pipe connections to manholes and other rigid structures.

## **2.02 HDPE PRESSURE PIPE**

- A. HDPE pressure pipe shall conform to requirements of HDPE pressure pipe within Section 334103 – HDPE Pipe and Fittings.

## **2.03 UNDERGROUND MARKING TAPE**

- A. Underground marking tape shall be green, at least four (4) inches wide, four mil thick, polyethylene tape, with a metallic backing capable of being traced with locators. The tape shall have black letters with the following wording: "Caution: Sewer Line Buried Below." The marking tape shall be installed 12 inches above the top of all sewer mains and services.

## **PART 3 - EXECUTION**

### **3.01 CONSTRUCTION**

- A. Excavation, bedding, and backfill shall conform to the requirements of Section 312002 - Trenching. Underground marking tape shall be installed as shown on the Drawings.
- B. Sheeting and bracing required for trenches shall be removed to the elevation of the conduit, but no sheeting will be allowed to be pulled, removed, or disturbed below the conduit. Sheeting and bracing shall meet OSHA requirements.
- C. Before lowering into the trench, the pipe shall be inspected for defects. All cracked, chipped, or broken pipe shall be discarded. The ends and interior of the pipe shall be clean. Belled ends shall be laid upgrade. Handling of the pipe shall be accomplished in a manner that will not damage the pipe. The joint shall be made in the manner recommended by the manufacturer. Care shall be taken not to buckle or disturb previously laid pipe.
- D. Pipe shall be laid accurately to the staked line and grade as indicated on the Drawings.
- E. Pipe shall be cleaned of all foreign matter, and water shall be kept out of trenches until joints have been completed. When WORK is not in progress, open ends of pipe and fittings shall be securely closed to keep foreign matter and animals from entering.
- F. Each joint shall be inspected to ensure that it is properly made before backfilling is done. Care shall be taken to prevent any dirt or foreign matter from entering the open end of the pipe. Where it is necessary to cut pipe, such cuts shall be neatly made in an approved manner. The laid pipe shall be true to line and grade and, when completed, the sewer shall have a smooth and uniform invert. No section of gravity sewer, including service connections, shall have an adverse grade which would pond water in the invert of the sewer.
- G. Connections to pipe stubs of a different pipe material shall be made with DFW/HPI non-shear-type connector, as shown in CBJ Standard Detail 218 - Coupling for Dissimilar Sanitary Sewer Pipes. Connectors must be approved by the DEPARTMENT prior to installation.
- H. Connections to existing sewer mains and manholes shall be made in such a manner so as to not damage the existing facility. Such connections shall be made so that no projections or rough surfaces occur within the pipe.

- I. All Sanitary Sewer Cleanouts shall be provided with a cast iron ring and cover which shall be locking-type Olympic Foundry No. M-1025, or approved equal as shown in the Drawings. The cover shall be clearly marked with the word "SEWER" cast into it.
- J. Where gravity flow sanitary sewers cross above or less than 18 inches below waterlines, or approximately parallel water lines within ten feet horizontally, the sewer pipe shall meet the requirements of ductile iron pipe or PVC pressure pipe, as described in Part 2 of this Section.
- K. HDPE to HDPE connections shall be made by thermal butt fusion in accordance with ASTM D2657. Fusion jointing shall utilize a pipe manufacturer approved fusion machine operated by experienced and qualified personnel. The CONTRACTOR shall provide three copies of a "Heat Fusion Qualification Guide," published by the HDPE manufacturer that provides criteria for inspection of thermal fusion joints. The guide shall include criteria for operator training requirements and experience; visual inspection criteria (including photographs) for both intact thermal fusion joints and sample strips cut for thermal fusion joints. The thermal fusion machine operator shall perform a minimum of three test joints in the presence of the DEPARTMENT. The test joints will be examined from both exterior appearances and from appearance of the joint cross section once the samples have been cut into strips.
- L. Bolted HDPE to HDPE connections shall include a polyethylene flange adapter (stub end) butt fused to the pipe, a backup flange ring, bolts, nuts and a gasket. Flange rings shall be Standard Steel ring Flanges, Class D, in accordance with AWWA C207. High strength bolts, nuts, washers and gaskets shall be in conformance with AWWA C207, Appendix A. Flange rings, bolts, nuts and washers shall be hot dip galvanized after fabrication per ASTM A153 and A386. Gasket dimensions and bolt lengths shall be per pipe manufacturer's recommendations.

### 3.02 TESTING

- A. Prior to testing, the sewer shall be complete, trenches shall be fully backfilled and compacted to finish grade, or, if the sewer is under pavement, finish pavement subgrade.
- B. For WORK involving placement of new sanitary sewer collection systems, all sections of pipe shall be tested for leakage using the Exfiltration Test for either air or water as specified hereafter; or, at the sole direction of the DEPARTMENT, when the normal water table is above the sewer throughout the section under test, the DEPARTMENT may permit use of the Infiltration Test procedure specified hereafter. Where leakage is in excess of the specified rate, the sewer shall be repaired by the CONTRACTOR as required to comply with the leakage test requirements. The DEPARTMENT may require the CONTRACTOR to repair obvious leaks even though the total length of the test section falls within the maximum allowable leakage for the test used.
- C. Defective pipe joints shall be repaired in a manner that the repaired pipe joint will have some flexibility and the effectiveness of the repair will not be affected by differential movement of the adjoining pipes. A "CSSI" or DFW/HPI non-shear coupling, as per CBJ Standard Detail 218 - Coupling for Dissimilar Sanitary Sewer Pipes, or approved equal, will be acceptable in making such repairs.
- D. The DEPARTMENT will make one complete TV inspection after all sewers have passed the specified watertightness test. All defects regarding sewer alignment and grade, damaged pipe, and visible leaks observed during this inspection, shall be corrected by the CONTRACTOR. The CONTRACTOR shall de-water the sewers as required for the

performance of the TV inspection work by the DEPARTMENT. The CONTRACTOR shall be responsible for all costs associated with any TV inspection required following the initial TV inspection, if any defects were observed during this or any subsequent TV inspections.

- E. The hydrostatic test procedure for HDPE Pipe shall consist of two (2) steps: the initial expansion phase and the test period. In order to accommodate the initial expansion of the pipe under test, sufficient make-up water shall be added to the system at hourly intervals for three hours to return to the test pressure. The test period begins after the final addition of make-up water in the expansion phase of the test procedure. The test period is three (3) hours. After this test period, a measured amount of make-up water shall be added to return to test pressure. The amount of make-up water shall not exceed the allowable expansion in U.S. gallons shown in the following table:

**THREE HOUR TEST**

Nominal Pipe Size (inches)	Allowance for Expansion (U.S. Gal. Per 100 feet of Pipe)
2	0.15
4	0.40
6	0.90
8	1.50

Under no circumstances shall the total test procedure exceed eight hours at 1.5 times the pipe pressure rating. If the test is not completed within eight hours, the test section shall not be re-tested for eight more hours. Repair and re-testing shall continue until a passing test is obtained.

**3.03 FILTRATION TEST (USING AIR)**

- A. The CONTRACTOR shall furnish all facilities and personnel for conducting the test under the observation of the DEPARTMENT. The equipment and personnel shall be subject to the approval of the DEPARTMENT. Joints only may be tested in pipe 36 inches in diameter or larger, at the option of the DEPARTMENT.
- B. Immediately following the pipe cleaning, the pipe installation shall be tested with low pressure air. Air shall be slowly supplied to the plugged pipe installation until the internal air pressure reaches five pounds per square inch greater than the average back pressure of any ground water that may submerge the pipe. At least two minutes shall be allowed for temperature stabilization before proceeding further.
- C. The pipeline shall be considered acceptable when tested at an average pressure of four psi greater than the average pressure of any ground water that may submerge the pipe if the section under test does not lose air at a rate greater than 0.0030 cubic feet per minute per square foot of internal surface.
- D. The requirements of this Specification shall be considered satisfied if the time required for the pressure to decrease from 4.5 psi to 3.5 psi above average ground water pressure is greater than that shown using the following formula:

$$T = 28.33 D$$

Where T = time in seconds  
D = pipe diameter in inches

- E. Pressure gauges should be incremented in not more than one-half pound increments for accurate tests.
- F. Braces shall be required to hold plugs in place and to prevent the sudden release of the compressed air. Due to the large forces that could be exerted by an escaping plug during the testing of the pipe, no one shall be allowed in the manholes in which plugs have been placed while tests are being conducted. The CONTRACTOR's testing equipment shall have a pressure relief device that will prohibit the pressure in the pipeline from exceeding ten pounds per square inch.

**3.04 EXFILTRATION TEST (USING WATER)**

- A. Where groundwater is below the pipe to be tested, a minimum of head of eight feet of water above the crown at the upper end of the test section shall be maintained for a period of four hours, during which time it will be presumed that full absorption of the pipe body has taken place, and thereafter for a further period of one hour for the actual test of leakage. During this one hour period, the measured loss shall not exceed the rate given below:

Type of Pipe	Allowable Exfiltration Rate
PVC	$E = 0.0004 DL$

E = Allowable leakage in gallons per hour  
D = Nominal inside diameter of pipe in inches  
L = Length of pipe being tested in feet

- B. Where groundwater is above any pipe to be tested, the minimum head of the test will be raised to provide an elevation head of eight feet above the groundwater.
- C. The maximum length of sewer in any test section shall be 500 feet.

**3.05 INFILTRATION TEST**

- A. Infiltration testing may be allowed at the DEPARTMENT's option when the natural ground water table is above the crown of the higher end of the test section and the external water pressure exerted on the pipe is equivalent to the exfiltration test. The maximum allowable limit for infiltration shall be as determined by the formulas defined in the above section Exfiltration Test (Using Water).

**3.06 PRESSURE SEWER TEST**

- A. The CONTRACTOR shall, in the presence of the DEPARTMENT, test all pressure sewer pipes to a test pressure of 100 pounds per square inch and maintain the pressure a minimum of one hour. The CONTRACTOR shall make all necessary arrangements to provide water for testing pipelines.
- B. Leakage shall not be in excess of five gallons per inch of pipe diameter per one thousand (1,000) feet of pipe per day. Where leakage is in excess of the specified rate, the CONTRACTOR shall make all repairs necessary to reduce the amount of leakage to a quantity within the specified rate. The testing and repair process shall be repeated until the installation is accepted. In addition, the CONTRACTOR shall repair all visible leaks.

**END OF SECTION**

**SECTION 33 39 13  
SANITARY SEWER MANHOLES AND CLEANOUTS**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing sanitary sewer cleanouts complete, in place as shown in the Drawings. It shall also include raising or lowering existing sanitary sewer manholes and cleanouts to conform to the final grade as shown on the Drawings.

**1.03 SUBMITTALS**

- A. Frame and Lids: Catalogue cuts and materials certification.

**PART 2 - PRODUCTS**

**2.01 MANHOLES**

- A. All manholes shall consist of precast concrete sections, including integral base section, riser sections, cones, and flat slab tops and shall conform to ASTM C 478 and the dimensions shown on the Drawings. All precast sections shall have joints sealed with "RAM-NEK" or "RUB-R-NEK" gasketing material, or approved equal, installed as specified by the manufacturer. Cones shall be eccentric. Manhole steps shall be cast in all precast manhole sections. Pipe penetration gaskets shall be cast into all precast manholes. Grade rings shall be standard product, manufactured particularly for use in manhole construction, sized to fit the cones on which they are placed, and the wall thickness shall be not less than that of the cones. Grade rings shall be not less than two inches high, nor more than four inches high. Grade rings shall be Infra-Riser® or approved equal.
- B. Portland cement concrete cast in place shall conform to Section 321314 – Concrete Structures.

**2.02 FRAMES, COVERS AND STEPS**

- A. Manhole frames and covers shall be watertight, of ductile iron, and conform to the design and dimensions shown on the Drawings. Ductile iron castings shall conform to the requirements of AASHTO M 103. Grade shall be optional unless otherwise designated. Contact surfaces between frames and covers shall be machined to provide a uniform contact surface. When watertight locking devices are specified, the CONTRACTOR shall submit Shop Drawings for approval by the DEPARTMENT.
- B. All manhole covers shall have the word "SEWER" cast into the top in letters approximately three inches high.
- C. Manhole steps shall be constructed of polypropylene conforming to ASTM D4101, and shall meet current state and federal safety standards.
- D. Frames and covers shall be ductile iron, conforming to ASTM A 48, Class 30. The cover shall be designed for the appropriate classification of traffic and shall have the word "SEWER" cast into the top with prominent letters. Bearing surfaces between the frame

and cover shall be machined to smooth, plane surfaces. Frames and covers shall be Inland Foundry No. 743, or approved equal.

### **2.03 MISCELLANEOUS**

- A. All pipes, bends and fittings used in cleanouts, drop connections, and pipe stubs for future connections to manholes shall conform to Section 333113 – Sanitary Sewer Pipe.
- B. Bentonite-Cement sealing plaster shall consist of two parts bentonite, one part Type 3 cement, and one part sand, with sufficient water to obtain workable consistency.
- C. Mortar shall consist of one part portland cement to two parts clean, well-graded sand which will pass a No. 4 screen. Admixtures may be used not exceeding the following percentages of weight of cement; hydrated lime, 10%; diatomaceous earth or other inert material, 5%. Consistency of mortar shall be such that it will readily adhere to the surface. Mortar mixed for longer than thirty minutes shall not be used. A non-shrink mortar may be submitted for approval as a substitute.
- D. Grout shall be a non-shrink type approved by the DEPARTMENT.
- E. Pipe penetration gasket through the manhole wall shall be cast-in-place Dura-Seal III, or approved equal, as manufactured by Dura-Tech, Inc., Kor-N-Seal Cavity O-Ring, or approved equal, as manufactured by NPC Inc. shall be used for filling the preformed void in the connection gasket.
- F. Manhole exterior joint waterproofing shall be a Miradri system as manufactured by Carlisle CCW, including Carlisle – CWW-715 Damp Concrete Contact Adhesive, CWW 704 primer, CCW Miradri 861 Membrane, and CCW 704 mastic, or approved equal that includes a membrane and adhesive system for positive water exclusion. The membrane shall extend at least 18" each side of manhole joints, except this width may be reduced to 9" each side of manhole joints if the joint is less than four feet below finished grade and the joint is above the maximum water table.

## **PART 3 – EXECUTION**

### **3.01 CONSTRUCTION**

- A. Precast concrete manhole bases sections shall be set on a level base of twelve inches of compacted D-1 or 2-inch minus shot rock as shown in the Drawings. Provisions shall be made to prevent flotation of the manhole.
- B. All lifting holes shall be plugged with Bentonite-Cement sealing plaster and sealed with a Miradri System patch, or approved equal, to a minimum of six inches from the edges of the opening, as required to prevent leakage.
- C. After completion of the manhole, all plugs shall be completely removed from the sewers and all loose material shall be removed from the manhole.
- D. Service connections shall not be installed into manholes unless otherwise shown on the Drawings or directed by the DEPARTMENT. Where service connections into manholes are allowed, the top of the service sewer pipe shall be 0.2 feet higher than the top of the downstream main sewer pipe. The manhole invert shall be channeled for the service connection sewers in the same manner as for main sewers.
- E. Stubs for future construction shall consist of a section of pipe extending two feet outside the manhole wall, connected as shown on the Drawings. The manhole fillet shall be formed for future connection. The stubs shall be located as shown on the Drawings.

- F. Connection to existing manholes shall be made in such a manner that the modified manhole is equal to a new manhole in appearance and performance. A channel, approximately two inches larger all around than the connecting pipe, shall be cut into the existing manhole base. The new pipe shall be connected as shown on the Drawings and Standard Details. The rough-cut channel shall be finished to its final smooth and uniform shape with mortar. The existing sewer(s) shall be maintained in service and the fresh concrete and mortar surface shall be protected from the flowing sewage for a minimum of 24 hours.
- G. The joint exterior waterproofing system shall be installed as recommended by the system manufacturer and as described in this Section.
- H. All manholes will be visually inspected by the DEPARTMENT; there shall be no evidence of leakage of water into any manhole from outside sources or any imperfections which may allow such leakage.
- I. At least 25% of the completed manholes, as selected by the DEPARTMENT, shall be tested for water-tightness by the CONTRACTOR. The test shall be made, with all connecting pipes plugged, by filling the manhole with clean water to within two inches of the bottom of the cast iron frame. The leakage rate shall not exceed three gallons per day per foot of depth, or fifty gallons per day, whichever is less, over a test period of not less than two hours when the water table is not an adverse factor. For every manhole that fails to meet the test, four additional manholes shall be tested.
- J. The CONTRACTOR shall repair all imperfections and leaks disclosed by either visual inspection or testing. The method of repair shall be subject to the DEPARTMENT's approval.
- K. Manhole Grade Ring Adjustment Units are required for each new sanitary sewer manhole, reconstructed sanitary sewer manhole, and adjustment of existing manhole to grade.
1. Each manhole shall contain at least one recycled rubber riser, with thickness varying to match frame and cover to finish grade requirements, to form the final surface for installation of the frame.
  2. The total height of the rubber adjustment riser shall be a minimum of 1" and a maximum of 3".
  3. Concrete and steel surfaces to receive sealing compound shall be clean, dry and free of grease or oils.
  4. Adjustment risers shall be bonded to adjacent surfaces by laying a continuous bead, 5/16" thick cold applied joint sealant compound conforming to ASTM-D 1850 (PL Premium POLYURETHANE Door, Window & Siding Sealant or PL Premium POLYURETHANE Concrete & Masonry Sealant, formerly Chemrex CX-22) or equivalent, on the top surface of the concrete course, or the bottom surface of the riser, on a diameter 1" smaller than the outside diameter of the rubber adjustment riser.
  5. The adjustment riser shall then be seated firmly in place, ensuring it is centered over the opening. Apply a second continuous strip of sealant to the top surface of adjustment riser, 0.5" from the outside diameter of the rubber adjustment riser or manhole frame.
  6. The adjustment riser must form the final surface for the seating of the frame and cover assembly. Concrete adjustment units must not form the final surface for seating the frame.
  7. If more than one adjustment riser is required, a continuous bead of sealant shall be applied between each unit in the same manner as in paragraph 4 above. A continuous bead of sealant shall also be placed on the top surface of the concrete

- course or on the bottom surface of the bottom riser and to the top surface of the top adjustment riser.
8. The frame shall then be set firmly in place ensuring that it is properly centered over the structure opening and is firmly contacting the rubber riser through the sealant.
  9. Adjustment risers shall have an inside diameter that is within 2" of the inside diameter of the concrete structure, and equal to the outside diameter of the concrete structure  $\pm 2$ ".
- L. Manhole frames and covers shall be set to final grade prior to final paving operations, with the compacted pavement to provide a depression to the top of manhole frame within the allowable limits of 3/8-inch minimum to 3/4-inch maximum, as determined by using an 8-foot long straight edge across the frame in all directions.
1. The frame can be set to final position prior to the laydown machine passing over the structure, or immediately following the laydown machine passing over the structure.
  2. The intended purpose of these requirements is that the asphalt pavement is compacted to grade around the frame and cover with no cut out of compacted pavement allowed.
  3. If the depression of the frame and cover below finish pavement is found to be out of allowable tolerances after the pavement has cooled to the point that sawcutting and removal of the pavement is necessary, the following corrective action will be required:
    - a. A square cut-out of the pavement shall be made to a minimum of 6-inches and maximum of 8-inches outside the edge of frame flange, with this cut-out oriented with the sides at 45° to traffic.
    - b. A concrete transition slab shall be constructed as shown in the detail on the Drawings. This slab shall be allowed to cure for a minimum of 48 hours before placing the hot asphalt mix over the transition slab.
- M. Manhole riser rings shall be sealed to the top of manhole cone or flattop and to each other with one run of "RAM-NEK" or "RUB-R-NEK" around the inside edge and one run around the outside edge of the riser ring. The units shall be heated and compressed to at least 50% of original thickness of the "RAM-NEK" or "RUB-R-NEK." No grout shall be used to seal the riser rings.

### **3.02 CONNECT TO EXISTING MANHOLE**

- A. CONTRACTOR shall remove or plug existing pipe as applicable, drill hole at new location required for installation of new sewer line under this contract, install pipe, seal the pipe penetration, form channeled inverts and backfill as required.

**END OF SECTION**

**SECTION 33 41 00  
STORM SEWER PIPE**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing pipe culverts, storm drains and underdrains, in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Drawings or as directed by the DEPARTMENT. The WORK also includes connecting to existing storm drain pipe.
- B. This WORK also includes furnishing and installing connecting bands, branch connections, elbows and end sections required to complete the culvert or drain structure.
- C. This WORK also includes installing and connecting foundation drains, roof drains and other drains to storm drain structures, including all fittings and elbows to make a satisfactory installation.

**1.03 SUBMITTALS**

- A. Storm Sewer Pipe: Material certifications stating conformance with requirements of this section and manufacturer's catalog cuts of pipe materials and fittings.

**PART 2 – PRODUCTS**

**2.01 PVC PIPE CONDUIT**

- A. PVC Pipe Conduit shall have a standard dimension ration (SDR) of 35 and conform to ASTM D 3034. Before any PVC pipe is used on this Project, the CONTRACTOR shall supply certifications, signed by an authorized agent of the seller or manufacturer, stating that the material has been sampled, tested, and inspected in accordance with ASTM D 3034.
- B. The pipe shall have integral wall bell and spigot joints conforming to ASTM D 3212. The bell shall consist of an integral wall section with a solid cross section elastomeric ring, factory assembled, securely locked in place to prevent displacement.
- C. Flexible watertight connections, approved by the DEPARTMENT, shall be used at PVC pipe connections to manholes and other rigid structures.

**2.02 CORRUGATED POLYETHYLENE PIPE**

- A. Corrugated polyethylene pipe (CPP) shall be high density corrugated polyethylene, smooth interior pipe, and shall be manufactured in conformity with the latest AASHTO M 294, Type S specification, and shall meet the requirements of ASTM D 3350 Cell Classification 324420C, or ASTM D 1248, Class C, Category 4, Grade P33.

- B. Pipe shall be joined with "Hancor, Inc. Hi-Q Sure-Lok" (bell-and-spigot) joint, or approved equal, meeting the requirements of AASHTO M 294. The bell shall be an integral part of the pipe and provide a minimum pull-apart strength of 400 pounds.
- C. The bell-and-spigot joint shall incorporate a gasket making it silt-tight. Gaskets shall be installed in the bell, or on the pipe, by the pipe manufacturer.
- D. Fittings shall conform to AASHTO M 294. Fabricated fittings shall be welded on the interior and exterior at all junctions. All fittings shall connect to the pipe with a bell and spigot joint.
- E. All cut corrugations on CPP pipe shall be cleared of all water and completely grouted to prevent the accumulation of water.

### **2.03 HDPE PRESSURE PIPE**

- A. HDPE pressure pipe shall conform to requirements of HDPE pressure pipe within section 334103 – HDPE Pipe and Fittings.

### **2.04 FOUNDATION AND WALL DRAINS**

- A. Foundation and wall drains shall be perforated PVC pipe conforming to Article 2.1 of this Section, with two rows of slots or perforations set at 60° from the invert position.

### **2.05 UNDERGROUND MARKING TAPE**

- A. Underground Marking Tape shall be yellow, at least 4-inches wide, 4-mil thick, polyethylene tape with a metallic backing capable of being traced with locators. The tape shall have black letters with the following wording: "Caution: Storm Sewer Line Buried Below", or similar. The marking tape shall be installed 12-inches above the top of all storm sewer mains and services.

## **PART 3 – EXECUTION**

### **3.01 CONSTRUCTION**

- A. Excavation, Bedding, and Backfill shall conform to the requirements of Section 312002 – Trenching. All pipe shall have a minimum cover of 12 inches, unless otherwise shown on the Drawings or directed by the DEPARTMENT.
- B. The pipe laying shall begin at the downstream end of the pipe. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid pipe and outside circumferential laps of flexible pipe shall be placed facing upstream.
- C. Joints shall be made with rubber gaskets.
- D. Flexible conduits shall be firmly joined by approved coupling bands.
- E. Conduit shall be inspected before any backfill is placed. Any pipe found to be substantially out of alignment, unduly settled, or damaged shall be taken up and relaid or replaced.

- F. Installation of all pipes shall conform to the manufacturer's recommended procedures. These Specifications and the Drawings shall take precedence over the manufacturer's recommendations in the event of conflict, if more restrictive.
- G. Pipe culvert shall be installed as shown on the Drawings, unless otherwise directed by the DEPARTMENT. All bends, couplings and other fittings necessary to connect to existing pipes or flows shall be approved by the DEPARTMENT.
- H. All cut corrugations on CPP pipe shall be cleared of all water and completely grouted to prevent the accumulation of water.

**END OF SECTION**

**SECTION 33 41 01  
STORM SEWER MANHOLES, INLETS, AND CATCH BASINS**

**PART 1 – GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing precast concrete storm sewer manholes and catch basins complete, in place as shown on the Drawings.

**1.03 SUBMITTALS**

- A. Storm Sewer Manholes shop drawings.
- B. Frames and Grates: Catalogue cuts and material certifications.

**PART 2 – PRODUCTS**

**2.01 JOINT MORTAR**

- A. Joint mortar shall be non-shrink-type, and shall consist of one part Portland cement and two parts approved sand with water as necessary to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation. If mortar is submerged and cannot be kept dry until cured, a substitute approved by the DEPARTMENT shall be used.

**2.02 FRAMES, GRATES, COVERS, AND LADDER RUNGS**

- A. Frames, grates, covers and ladder rungs shall conform to the plan dimensions and to the following Specification requirements for the designated materials:
  1. All frames, grates, and covers shall be ductile iron, conforming to ASTM A 48, Class 30, and shall be designed for heavy duty traffic.
  2. Carbon-steel castings shall conform to the requirements of AASHTO M 103. Grade shall be optional unless otherwise designated.
  3. All manhole covers shall have the words "STORM DRAIN" cast into the top in letters approximately three inches high.
  4. Structural steel shall conform to the requirements of AASHTO M 183.
  5. Manhole steps shall be constructed of polypropylene conforming to ASTM D 4101 and shall meet current state and federal safety standards.
  6. Galvanizing, where specified for these units, shall conform to the requirements of AASHTO M 111.
  7. Malleable iron castings shall conform to the requirements of ASTM A 47. Grade shall be optional unless otherwise designated.

### 2.03 REINFORCING STEEL

- A. Reinforcing steel shall conform to the following applicable requirements:
- |                                  |                                    |
|----------------------------------|------------------------------------|
| Deformed Billet-Steel Bars       | AASHTO M 31 (ASTM A 615, grade 60) |
| Welded Steel Wire Fabric         | AASHTO M 55 (ASTM A 185)           |
| Cold-Drawn Steel Wire            | AASHTO M 32 (ASTM A 82)            |
| Fabricated Steel Bar or Rod Mats | AASHTO M 54 (ASTM A 184)           |

### 2.04 PRECAST CONCRETE UNITS

- A. Precast concrete units shall conform to the requirements of AASHTO M 199, except that the absorption test will not be required.
- B. Cracks in units will be cause for rejection. Honeycombed or patched areas in excess of 30 cumulative square inches will be cause for rejection.
- C. Concrete shall conform to Section 321314 – Concrete Structures.
- D. Manhole steps shall meet current state and federal safety standards.

## PART 3 – EXECUTION

### 3.01 CONSTRUCTION

- A. Concrete construction shall conform to the requirements of Section 321314 – Concrete Structures.
- B. Welding shall be done in accordance with the best modern practice and the applicable requirements of AWS D1.1 except as modified by AASHTO “Standard Specifications for Welding of Structural Steel Highway Bridges.”
- C. New and existing metal frames shall be set in full mortar bed.
- D. Manholes and catch basins shall be constructed in accordance with the Drawings. There shall be a minimum 16 inch catch constructed in the invert of the manholes or catch basins, unless otherwise specified. After the mortar is set, holding the pipe in place, the pipe is to be cut off evenly so that neither more than two inches, nor less than one inch, of the pipe protrudes into the manhole or catch basin.
- E. When a pipe enters the manhole through a wall of a precast unit, the CONTRACTOR shall perform the cutting of the concrete and steel reinforcement in a manner that will not loosen the reinforcement in the wall. The steel reinforcement shall be cut flush with the wall face. All joints and openings cut in the walls shall be grouted.
- F. Where indicated on the Drawings, a stub shall be provided for future connections to the manhole. The stub shall be sized and positioned as indicated. The end of the stub shall be stopped with a wooden plug, concrete biscuit, or other adequate methods to prevent water, earth, or other substances from entering pipe.

- G. Adjustment of Existing Frame Grates to Grade shall consist of raising or lowering the frame or ring casting one foot or less and providing the necessary adjusting rings, and mortar required to adjust the frame and grate to finish grade, as shown in the Drawings.
- H. Replacing Frame and Covers shall consist of removal and disposal of the existing frame, cover and adjustment bricks, blocks and mortar and replacing with a new frame and cover and new precast storm drain manhole barrel section per the Drawings. The new frame and cover shall be adjusted to finish grade as shown in the Drawings.
- I. The manholes shall be reconstructed to the required elevation and to conform essentially to the details on the Drawings. This WORK shall conform to the requirements above specified for new construction except that material may be reused if of satisfactory quality and if approved by the DEPARTMENT.
- J. Existing storm flow shall not be impeded during construction.
- K. Excavation, bedding and backfilling shall conform to the requirements of Section 312002 – Trenching.
- L. Manhole pipe connections shall be made as shown on the Drawings and as required by the manufacturer's recommendations. A snug, watertight seal shall be provided for each pipe connection.
- M. All manholes shall be bedded in accordance with the Drawings.

**END OF SECTION**

**SECTION 33 41 02  
STORM WATER LIFT STATION**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. Section includes specifications for packaged storm water pump lift stations.

**1.02 REFERENCE STANDARDS**

- A. American Society for Testing and Materials (ASTM International):
1. C443 Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
  2. C478 Specification for Precast Reinforced Concrete Manhole Sections

**1.03 DEFINITIONS**

- A. NEMA: National Electrical Manufacturers Association.

**1.04 PERFORMANCE REQUIREMENTS**

- A. Operating Conditions: Each pump shall be capable of delivering scheduled flow at scheduled dynamic head. All openings and passages shall be large enough to permit the passage of a sphere three (3) inches in diameter.

**1.05 SUBMITTALS**

- A. Product Data:
1. Dimensional drawings of lift station drawn to scale indicating components and connections to other equipment and piping.
  2. Indicate pump type, capacity, and power requirements.
  3. Certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include net positive suction head (NPSH) curve and total dynamic head (TDH) calculations.
  4. Include a performance chart for motor showing curves for torque, current, power, factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.
  5. Mass moment of inertia calculations for the impellers upon the DEPARTMENT's request.
  6. Indicate materials of construction.
  7. Electrical characteristics and connection requirements.
- B. Shop Drawings: The shop drawings shall include the following:
1. Dimensions of sump manhole, equipment, anchors, steps or ladders, pipe supports, attachments, lifting points, tappings, drains, piping, valve, fittings, float switches and access cover and locking hardware.
  2. Structural calculations and shop drawings for precast reinforced concrete valve vault manhole and other precast drainage structure components.
  3. Any fabricated items not detailed on Contract Drawings.

### **1.06 DELIVERABLES**

- A. Submit certificates of factory and manufacturer's representative's on-site inspection, testing, and approval to the DEPARTMENT.
- B. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

### **1.07 QUALITY ASSURANCE**

- A. Notify the DEPARTMENT prior to, and perform all testing during, progress of the work in the presence of the DEPARTMENT's representative.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum ten years' experience.
- C. Structural calculations and shop drawings for precast reinforced concrete valve vault manhole and other precast drainage structure components shall be sealed and signed by a registered structural engineer licensed in the State of Alaska.

### **1.08 WARRANTY**

- A. Warranty: Submit five year manufacturer warranty and ensure forms have been completed in the DEPARTMENT's name and registered with manufacturer.

## **PART 2 - PRODUCTS**

### **2.01 GENERAL**

- A. Equipment and appurtenances for packaged storm water lift station shall include two pumps; valves; internal piping; central control panel with circuit breakers; motor starters; level controls; electrical controls and wiring; electrical service connection; precast concrete valve pit vault; concrete work; and miscellaneous appurtenances.
- B. Provide pumps with manufacturer's name, model number, and rating/capacity clearly identified.
- C. Provide pumps complete with the following features and appurtenances:
  - 1. Submersible, centrifugal, duplex arrangement, non-clog pumps.
  - 2. Precast reinforced concrete valve vault manhole structure, galvanized steel steps, pipe supports, and similar items.
  - 3. Pump guide rails shall be custom stainless steel construction and shall allow pump lift-out assembly and pump to move from bottom of guide to top of guide without binding. The lift-out assembly shall be easily removable from the top of rail.
  - 4. Liquid level sensors, control panel complete with starters, alternator, controls, and alarm lights.
  - 5. Plumbing: Provide each pump discharge with a check valve and a gate valve.
  - 6. The motor and pump shall be designed and assembled by the same manufacturer.
  - 7. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity.

## **2.02 SUBMERSIBLE CENTRIFUGAL NON-CLOG PUMPS**

- A. Pumps: Submersible centrifugal non-clog type for wet pit installation, capable of continuous submergence to the maximum depth indicated in the Contract Documents.
- B. When lowered on its guide rail, each pumping unit shall be automatically and firmly connected to a discharge fitting permanently mounted on the discharge pipe. Sealing of the discharge connection by means other than metal to metal contact of the pump discharge flange and the discharge fitting will not be acceptable. The guide rail system shall be furnished, complete by the lift station manufacturer or in accordance with manufacturer's recommendations. Each pump shall be equipped with a lifting chain and power cable of sufficient strength and length to permit easy removal for inspection or repair.

## **2.03 MOTOR**

- A. Pump Motor: Induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber, NEMA B type. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 311 degrees F. The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The motor shall be designed for continuous duty handling pumped media of 104 degrees F and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 260 degrees F shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.
- B. The combined service factor shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10 percent. The motor shall be designed for operation up to 104 degrees F ambient and with a temperature rise not to exceed 144 degrees F.
- C. Motors shall be sufficiently cooled by the surrounding environment or pumped media. A water cooling jacket shall not be required.
- D. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.
- E. Motors shall be capable of continuous submergence to a depth of 65 feet without loss of watertight integrity.

## **2.04 ELECTRICAL CABLE AND PROTECTION**

- A. Size power cable in accordance with the National Electric Code (NEC) and Insulated Cable Engineers Association (ICEA) standards with sufficient length to reach the junction box above sump pit without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber.
- B. The cable entry seal design shall include specific torque requirements to ensure a watertight and submersible seal. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable.

- C. All starters shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 260 degrees F, the thermal switches shall open and stop the motor.

## **2.05 BEARINGS**

- A. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces.

## **2.06 MECHANICAL SEAL**

- A. Provide each pump with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in an oil reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary ceramic seal ring and one positively driven rotating carbon seal ring. Each seal interface shall be held in contact by its own spring system. Each pump shall be provided with an oil chamber for the shaft sealing system.

## **2.07 PUMP SHAFT**

- A. Pump motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Coupling shall not be acceptable. The pump shaft shall be stainless steel.

## **2.08 IMPELLER**

- A. Impellers: Gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design having a long through outlet without acute turns. The impellers shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in storm water. Impellers shall be retained with an allen head bolt and shall be capable of passing a minimum 3 inch diameter solid. All impellers shall be coated with alkyd resin primer.

## **2.09 WEAR RINGS**

- A. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impellers. The wear ring shall be stationary and made of brass, which is drive fitted to the volute inlet.

## **2.10 VOLUTE**

- A. Pump Volute: Single-piece gray cast iron, Class 30, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller.

## **2.11 PIPING**

- A. Piping associated with the plumbing system of the storm water lift station and its discharge pipe shall be ductile iron with mechanical joints for buried service and galvanized steel for exposed service in the sump and the valve vault.
- B. The pump discharge piping embedded in concrete shall be welded steel with flanged ends, hot dip galvanized after fabrication.

## 2.12 ELECTRICAL CONTROLS

- A. Design standard duplex control panel to operate two submersible pumps based on wet well level monitored by level sensors. There shall be three (3) level sensors required for automatic operation of duplex pump station and (1) level sensor for high level alarm. The controls shall be float operated, duplex, with corrosion resistant floats to alternate operation of pumps and cut-in the second pump on rising level or lead pump failure. Provide additional set of wired terminals for future wiring of a remote alarm circuit.
- B. The NEMA 1 control pump panel shall include the following:
1. Integral fused main switch
  2. Pump short circuit protection
  3. Pump overload protection
  4. Pump direct on-line contactors
  5. Two (2) sets start capacitors and two (2) sets run capacitors
  6. Control transformer
  7. Control transformer primary and secondary protection
  8. Electromechanical and solid state logic components for interface with wet well level sensors, built-in pump sensors and selected standard options.
  9. Pump and control terminal blocks
  10. Panel mounted pilot lights and operators
  11. NEMA 1 padlock enclosure and mounting components
  12. Intrinsically safe relays for float circuits
  13. High water alarm: Flashing light (red), pump No. 1 operating light (green), and pump No. 2 operating light (green) to be mounted on controller enclosure door.
  14. H-O-A switches and status transformer type pilot lights
  15. Utility 120 volts duplex receptacle fed from separate internal 1 Kva transformer
  16. Elapsed time meter
  17. Lightning suppresser
  18. Remote light contacts
  19. Individual pump starters with "soft start" modules and breakers
  20. Alternator relay and override relay
  21. Front of panel reset push-button
- C. All of the items shall be UL approved and provided with requirements as specified hereinafter.
- D. Sequence of operation of duplex controls shall be as follows:
1. When water level in pump pit reaches level sensors No. 2 (lead pump start sensor), the alternator provided for charging pump No. 1 and pump No. 2 duty (lead-lag alternating) will change its state and lead pump contactors will be energized. If water level continues to rise and reaches level sensor No. 3 (lag pump start sensor), the lag pump contactors will be energized until water level drops to level sensor No. 1 (pump's stop sensor).

2. Auxiliary contacts of pump circuit breakers shall be introduced into the circuitry in such a way that pump's contactors will be de-energized if circuit breaker trip condition occurs.
3. Auxiliary contacts of thermal overload relays shall be introduced into the circuitry so that pump's contactors are de-energized should a motor overload condition occur.
4. Pump motor windings thermal switch shall be introduced into the circuitry via a control relay so that a pump's contactor is de-energized should high temperature of motor windings occur. It shall not be possible for pump to restart automatically but front of panel reset push- button shall be provided for manual clearing of the fault.
5. If the inflow to the station is greater than the combined capacity of both pumps, the liquid levels will rise to the High Level Sensor No. 4 and send a signal to red alarm light.
6. Flashing red light alarm trouble light indicates any trouble or failure of pumps to drain wet well.

### **2.13 PRECAST REINFORCED CONCRETE VALVE VAULT MANHOLE**

- A. Reinforced concrete sump manhole shall conform to ASTM C478 and the applicable material and installation requirements of Sections 334101 Storm Sewer Manholes, Inlets and Catch Basins.
- B. Ground Surface Elevation: As indicated in the Contract Documents.
- C. Ground Water Table Elevation: As indicated in the Contract Documents.
- D. Static Loads & Dynamic (Seismic) Loads: Refer to Geotechnical Investigation Report.
- E. Uplift: Refer to the Buoyancy Safety Factor specified in the Contract Documents and to contract-specific Geotechnical Investigation Report.
- F. Maximum Bearing Pressure: 4000 psf.
- G. Excavate and perform backfill operations for valve vault manhole as specified in Section 312001 – Excavation and Embankment. Unless otherwise noted, place 18 inch deep crushed gravel over the bearing soil to provide a firm-bearing surface for the manhole foundation.
- H. Pipe to Precast Reinforced Concrete Sump Flexible Couplings: Shall conform to SSWPC Section 208-6. Couplings shall resist mild exposure to petroleum products.
- I. Joints shall be bell and spigot, single rubber O-ring gasketed, conforming to ASTM C443.
- J. Access cover shall be cast iron and designed for H-20 loading with lockable hardware.
- K. Exterior surfaces of the manhole structure shall receive two coats, 7 mils per coat of "Kop-Coat" Bitumastic (Coal Tar) Super Service Black Coating System as manufactured by the Carbolite Company, or DEPARTMENT approved equal.
- L. Provide knockouts in top slab of precast concrete structure to facilitate installation of electrical conduits, vent piping, and similar protrusions. Coordinate number and size of knockout requirements with storm water lift system equipment. Do not use access cover to facilitate the above.

#### **2.14 PUMP CONTROL/ELECTRICAL ROOM**

- A. Light for Outside Wall of Electrical Room: Provide exterior red light with vapor proof enclosure. Refer to Electrical Controls Article herein. This light shall flash indicating any trouble or failure of pumps to drain wet well.

#### **2.15 VALVE ACCESS HATCHES**

- A. The frame shall be of a single leaf design for H-20 loading and of sizes as shown on the Contract Drawings or the approved shop drawings.
- B. Hatch: Extruded aluminum with an integral anchor flange and seat. Equip with a flush aluminum drop handle which does not protrude above the cover and an automatic hold open arm with red vinyl grip on a release handle. Hinges shall be all stainless steel with tamper proof stainless steel bolts and nuts, and be removable for maintenance after the access door is cast in place. Access door shall be furnished with mill finish, cable holder, holes for cable holder and guide bracket. Aluminum surfaces which will be in contact with concrete shall be coated with "Bitumastic 300M" as manufactured by Kop-Coat or DEPARTMENT approved equal.
- C. Equip access hatch with locking assembly consisting of self-latching stainless slam lock and with a recessed hasp so that it can be locked with a padlock. The assembly shall not create obstruction or hazard for pedestrian traffic.

#### **2.16 PUMP ACCESS HATCH**

- A. Access Hatch: Dual leaf design for H-20 loading and of a size as shown on the Contract Drawings or the approved shop drawings.
- B. Hatch: Extruded welded steel with an integral anchor flange and seat equipped with a flush steel drop handle, which does not protrude above the cover and an automatic hold open arm with red vinyl grip on a release handle. Hinges shall be all stainless steel with tamper proof stainless steel bolts and nuts, and be removable for maintenance after the access door is cast in place. Access door shall be furnished with slip resistant galvanized diamond plate steel, Torsion spring assisted access door with hold open attachments. All parts shall be hot dipped galvanized. The walking surface shall be non-slip and rated for pedestrian service.
- C. Equip access hatch with locking assembly consisting of self-latching stainless slam lock and with a recessed hasp so that it can be locked with a padlock. The assembly shall not create obstruction or hazard for pedestrian traffic.

#### **2.17 SOURCE QUALITY CONTROL**

- A. Perform tests to verify operation of electrical circuits and devices prior to shipment.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION**

- A. Ensure pumps operate at specified system fluid temperature without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of mid-point of published efficiency curve.

- B. Coordinate the size of the precast concrete manhole sump structure with the storm water lift station system equipment, including but not limited to pumps, plumbing and electrical components. Ensure that there is adequate space within the structure to remove both pumps and to access the structure to perform periodical maintenance.
- C. Install plumbing and electrical components of the storm water pump system in accordance with the applicable Sections of Division 22 - Plumbing, and applicable Sections of Division 26 - Electrical.

### **3.02 START-UP, TESTING AND INSPECTION**

- A. Provide services of manufacturer's representative on-site to assist with the start-up, testing, and inspection after the packaged storm water pump system has been installed.
- B. The manufacturer's representative test shall include:
  - 1. Megger starter and power cables.
  - 2. Check seal lubrication.
  - 3. Check for proper rotation.
  - 4. Check power supply voltage.
  - 5. Measure motor operated load and no load current.
  - 6. Check level control operation and sequence.
  - 7. Single pump and dual pump operation test on manual and automatically as directed by the level control system.

### **3.03 FIELD QUALITY CONTROL AND INSPECTION**

- A. Pressure test entire assembly (pump discharge piping) prior to embedding in concrete.
- B. After completion of the work of this Section and with the agreement of the DEPARTMENT, place storm water pump system in operation. Acceptance will not be made until the system has operated satisfactorily for a period of not less than 30 days from the date designated by the DEPARTMENT. This test period shall be included with the specified contract time. Operation of the system shall not in any way be construed as an acceptance of the system, or any part of it, or as a waiver of any of the provisions of this Contract. The CONTRACTOR shall be responsible for the system during this period of operation. Make any adjustments or repairs which may be required and remedy defects or damages which may occur. The DEPARTMENT will pay the electrical energy cost consumed by the system during this trial operation.

### **3.04 TRAINING**

- A. Provide training for DEPARTMENT personnel as specified in Section 017900 – Demonstration and Training.

**END OF SECTION**

**SECTION 33 41 03  
HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS**

**PART 1 – GENERAL**

**1.01 SECTION DESCRIPTION**

This specification includes but is not limited to high-density polyethylene (PE 3408) (ductile iron pipe size O.D) pressure pipe primarily intended for the transportation of water and sewage either buried or above grade.

**1.02 REFERENCES**

Reference:	Title:
AWWA C901	Polyethylene (PE) pressure Pipe & Tubing, ½ inch through 3 inch for water
AWWA C906	Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water
ASTM D3035	Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Butt Heat Fusion PE Fittings for PE Pipe & Tubing
ASTM D3350	Standard Specification for PE Pipe & Fittings Materials
ASTM D1238	Melt Flow Index
ASTM D1505	Density of Plastics
ASTM D2837	Hydrostatic Design Basis
NSF Std.#14	Plastic Piping Components & Related Materials
TR-33/2005	Generic Butt Fusion Joining Procedure for Field Joining of PE Pipe

**1.03 GENERAL**

**A. USE**

High Density Polyethylene (HDPE) pipes/fittings shall be allowed for use as water, wastewater and reclaimed water pressure pipe where compatible with the specific conditions of the project. All material used in the production of water main piping shall be approved by the National Sanitation Foundation (NSF).

**B. DOCUMENTATION**

1. Documentation from the resin's manufacturer showing results of the following tests for resin identification:
  - a. Melt Flow Index ASTM D1238
2. Density ASTM D1505

C. MANUFACTURER

All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc., SCLAIRPIPE as manufactured by DuPont of Canada or equal as approved by the DEPARTMENT.

D. FINISHED PRODUCT EVALUATION

1. Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which become part of the manufacturer's permanent records.
  - a. Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)
  - b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.
  - c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.
  - d. Pipe length shall be measured.
  - e. Pipe marking shall be examined and checked for accuracy.
  - f. Pipe ends shall be checked to ensure they are cut square and clean.
  - g. Subject inside surface to a "reverse bend test" to ensure the pipe is free of oxidation (brittleness).

E. STRESS REGRESSION TESTING

The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.

F. COMPATIBILITY

Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

G. WARRANTY

The pipe MANUFACTURER shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the OWNER. The MANUFACTURER shall replace at no expense to the DEPARTMENT any defective pipe/fitting material including labor within the warranty period.

## **PART 2 – PRODUCTS**

### **2.01 MATERIALS FOR PIPE SIZES 4-INCH DIAMETER AND LARGER**

- A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345434C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.
- B. High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C906.
- C. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- D. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.
- E. HDPE pipe and accessories 4-inch diameter and larger, shall be 160 psi at 73.4<sup>0</sup>F meeting the requirements of Standard Dimension Ration (SDR) 17 as MINIMUM STRENGTH.
- F. The pipe Manufacturer must certify compliance with the above requirements.

### **2.02 MATERIALS FOR PIPE SIZES 2-INCH DIAMETER AND LESS**

- A. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345434C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.
- B. High Density Polyethylene (HDPE) pipes shall comply with AWWA Specifications C901.
- C. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- D. Dimensions and workmanship shall be as specified by ASTM D3035. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.
- E. HDPE pipe and accessories 2" and less in diameter, shall be 160 psi at 73.4<sup>0</sup>F meeting the requirements of Standard Dimension Ration (SDR) 9 as MINIMUM STRENGTH.
- F. The pipe Manufacturer must certify compliance with the above requirements.

### 2.03 FITTINGS

- A. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the DEPARTMENT.
- B. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.
- C. All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters and must be approved by the DEPARTMENT. No size on size wet taps shall be permitted.
- D. All transition from HDPE pipe to ductile iron or PVC shall be made per the approval of the DEPARTMENT and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter within a carbon steel back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A 316 stainless steel back-up ring shall mate with a 316 stainless steel flange per ANSI B16.1.
  - 1. Transition from HDPE to ductile iron fittings and valves shall be approved by DEPARTMENT before installation.
  - 2. No solid sleeves shall be allowed between such material transitions.
  - 3. Fittings and transitions shall be as manufactured by phillips DRISCOPIPE, Inc., 1000 Series Pressure Pipe, Chevron Chemical Company Plexco/Spiralite pipe, or equal.
  - 4. The pipe supplier must certify compliance with the above requirements.

### 2.04 PIPE IDENTIFICATION

- A. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-feet:
  - 1. Name and/or trademark of the pipe manufacturer.
  - 2. Nominal pipe size.
  - 3. Dimension ratio.
  - 4. The letters PE followed by the polyethylene grade in accordance with ASTM
  - 5. D1248 followed by the hydrostatic design basis in 160's of psi, e.g., PE 3408.
  - 6. Manufacturing standard reference, e.g., ASTM F714 or D-3035, as required.
  - 7. A production code from which the date and place of manufacture can be determined.
  - 8. Color Identification, either stripped by co-extruding longitudinal identifiable color markings or shall be solid in color and as follows:
    - a. BLUE – Potable Water
    - b. GREEN – Sanitary Sewer
- B. Marking Tape: Marking tape shall be installed per the Drawings.

### **PART 3 - EXECUTION**

#### **3.01 JOINING METHOD**

- A. The pipe shall be joined with butt, heat fusion joints as outlined in ASTM D2657 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33/2005, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the DEPARTMENT inspector.
- B. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet.
- C. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of a DEPARTMENT Inspector. The following shall apply:
  - 1. Heating plate surfaces shall be inspected for cuts and scrapes and shall be free of dirt and residue. Heater surfaces should be between 400°F (minimum) to 450°F (maximum). Measure the temperature @ 12:00, 3:00, 6:00 and 9:00 o'clock positions using a pyrometer or infrared thermometer at locations where the heating plate will contact the pipe/fitting ends. The maximum temperature difference between any two points on a single heating surface must not exceed 24°F. If this temperature is exceeded, the heating plate shall be cleaned per the manufacturer's recommendations.
  - 2. The fusion or test section shall be cut out after cooling completely for inspection.
  - 3. The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).
  - 4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum 3/16".
- D. The polyethylene flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternatively and evenly. After installation, apply a bitumastic coating to bolts and nuts.

#### **3.02 INSTALLATION**

- A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.
- B. HDPE shall be installed by Open Trench Construction.

- C. Care shall be taken in loading, transporting and unloading to prevent damage to the pipe. Pipe or fitting shall not be dropped. All pipe or fitting shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the DEPARTMENT. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the CONTRACTOR, at his own expense.
- D. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon "pull-back".
- E. Care shall be taken during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.
- F. Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.
- G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
- H. Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.
- I. Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings.
- J. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.
- K. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined.
- L. The pipe shall be joined by the method of thermal butt fusion, as outlined in PART 3 – Execution, Section 3.01 Joining Method. All joints shall be made in strict compliance with the manufacturer's recommendations.
- M. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:
  - 1. A polyethylene flange shall be thermally butt-fused to the stub end of the pipe.
  - 2. A 316 stainless steel back up ring shall mate with a 316 stainless steel flange.
  - 3. 316 stainless steel bolts and nuts shall be used.
- N. Flange connections shall be provided with a full-face neoprene gasket.
- O. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.
- P. If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the DEPARTMENT. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

Q. Open Trench Installation:

1. Specification, Section 312002 – Trenching shall apply in its entirety.
2. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.
3. Good alignment shall be preserved during installation. Deflection of the pipe shall occur only at those places on design drawings and as approved by the DEPARTMENT. Fittings, in addition to those shown on the Drawings, shall be used only if necessary or required by the DEPARTMENT.
4. Each length of the pipe shall have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be “pulled” or “cramped”.
5. Precautions shall be taken to prevent flotation of the pipe in the trench.
6. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.
7. Restrained joints shall be installed where shown on the Drawings or as directed by the DEPARTMENT.

**3.03 CLEANING**

- A. At the conclusion of the work, thoroughly clean all of the new pipe lines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period by forcing a cleaning swab through all mains 4” or greater. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the DEPARTMENT’s Inspector. Debris cleaned from the lines shall be removed from the job site.

**3.04 TESTING**

- A. Pressure testing shall be conducted per Manufacturer’s recommendations and as approved by the DEPARTMENT.
- B. All HDPE water lines shall be disinfected prior to pressure testing as per specification, Section 331113 – Water Pipe.
- C. All HDPE mains shall be field-tested. CONTRACTOR shall supply all labor, equipment, material, gages, pumps, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.
- D. All mains shall be tested at 150 percent of the operating design pressure of the pipe unless otherwise approved by the DEPARTMENT.

- E. Pressure testing procedure shall be per Manufacturer's recommendations or as follows:
1. Fill line slowly with water. Maintain flow velocity less than 2 feet per second.
  2. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation.
  3. Apply initial test pressure and allow to stand without makeup pressure for two to three hours, to allow for diametric expansion or pipe stretching to stabilize.
  4. After this equilibrium period, apply the specified test pressure and turn the pump off. The final test pressure shall be held for one to three hours.
  5. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the DEPARTMENT's representative at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the DEPARTMENT.
- F. Allowable amount of makeup water for expansion during the pressure test shall conform to Chart 6, Allowance for Expansion Under Test Pressure, Technical Report TR 31/9-79, published by the Plastic Pipe Institute (PPI). If there are no visual leaks or significant pressure drops during the final test period, the installed pipe passes the test.
- G. If any test of pipe laid disclosed leakage significant pressure drop greater than the manufacturer's recommended loss, the CONTRACTOR shall, at his/her own expense, locate and repair the cause of leakage and retest the line. The amount of leakage, which will be permitted, shall be in accordance with AWWA C600 Standards.
- H. All visible leaks are to be repaired regardless of the amount of leakage.
- I. The CONTRACTOR must submit his plan for testing to the DEPARTMENT for review at least 10 days before starting the test and shall notify the DEPARTMENT's Inspector a minimum of 48 hours prior to test.

**END OF SECTION**

**SECTION 33 46 00  
UNDERDRAIN**

**PART 1- GENERAL**

**1.01 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.

**1.02 SUMMARY**

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing underdrain as shown on the Drawings.

**PART 2 - PRODUCTS**

**2.01 MATERIAL**

- A. The type and size of underdrain pipe to furnished shall be as specified on the Drawings.
- B. Slotted or perforated and non-perforated corrugated steel pipe shall conform to the requirements of AASHTO M 36.
- C. Slotted or perforated and non-perforated corrugated aluminum alloy pipe shall conform to the requirements of AASHTO M 196.
- D. Slotted or perforated and non-perforated corrugated polyethylene (CPP) plastic pipe shall conform to the requirements of AASHTO M 252.
- E. Slotted or perforated and non-perforated polyvinyl chloride (PVC) plastic pipe shall conform to the requirements of ASTM D 3034.
- F. Slotted pipe shall have at least two rows of slots cut perpendicular to the axis of the pipe or at right angles to the pitch of corrugations and with the centerlines of the rows separated by one-third the circumference of the pipe. Slots shall have a width between one-sixteen inch and one-tenth inch and shall have a length, as measured along the inside circumference, of one inch to one and one-fourth- inch. Spacing of the slots shall be between three-fourth-inch and one and one-half-inch along the axis of the pipe. Slots shall be formed in such a way that inflow of water through the slots will not be impeded by excessive residual material from the slotting procedure.
- G. Granular backfill material shall be placed to the dimensions as shown on the Drawings or the Standard Details, and shall meet the following gradation:

<u>Sieve Designation</u>	<u>Percent Passing</u>
2-inch	100
No. 4	0-10
No. 100	0-3

- H. Filter cloth for underdrain trenches shall be Type A, as specified under Section 323000 - Filter Cloth.

**PART 3 - EXECUTION**

**3.01 CONSTRUCTION**

- A. Trenches shall be excavated to the dimensions and grade shown on the Drawings or as directed by the DEPARTMENT. A nominal two inch layer of granular backfill material shall be placed and compacted in the bottom of the trench for its full width and length.
- B. Filter cloth, if called for on the Drawings, shall be placed as shown on the Drawings.
- C. Perforated pipe shall be placed with the perforations down. The pipe sections shall be joined securely with the appropriate coupling bands or fittings.
- D. After the pipe installation has been inspected and approved, granular backfill material shall be placed and compacted to a height of 12 inches above the top of pipe. The remainder of the granular backfill material shall then be placed and compacted in six inch maximum layers to the required height.
- E. Any remaining portion of trench above the granular backfill shall be filled with either granular or impervious material, as may be specified, and thoroughly compacted. Compaction shall be as specified in Section 312002 - Trenching.

**END OF SECTION**



