PROJECT MANUAL – VOLUME II

Permit Set

Wesley Bradley Park
Phase 2 - Care Center

Puyallup, Washington

December 2, 2024

Owner
Wesley Homes
815 S. 216th Street
Des Moines, WA 98198

Owner's Developer
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MECHANICAL SPECIFICATION INDEX

SECTION 21 00 10
GENERAL CONDITIONS

Part 1. - GENERAL

1.1 SUMMARY

A. General and Supplementary conditions within Division 0 and 1 are hereby incorporated and become part of these Specifications, covering all work in Mechanical Division.

B. Before submitting a proposal on the project, the Contractor shall visit the site and familiarize themselves with the conditions and limitations affecting Mechanical Division work. No additional costs to the Owner shall be allowed for items verifiable during site visits.

C. Contractor shall provide sufficient workers and materials to keep pace with the construction schedule. Contractor shall place orders for equipment such that job progress is not slowed due to late delivery and shall confirm delivery dates with suppliers.

D. The Contractor shall provide office space and storage for materials and equipment supplied. Location shall be as directed by the General Contractor or the Architect/Engineer.

E. Upon completion of the work shown and specified under Mechanical Division and prior to final close out of the Project, the Contractor shall verify in writing that all systems are 100% complete and operating properly. This notification shall include copies of all Subcontractor notifications. Any system not operating properly at final inspection shall be immediately repaired and demonstrated to the Engineer.

F. Rebates or credits provided by utility companies or equipment manufacturers shall be directly credited to the Owner. The Contractor shall identify, coordinate and manage applications for these rebates or credits.

G. The Contractor shall electronically record all training sessions called for within other specification sections and include a copy of each within the Operations and Maintenance Manuals.

1.2 MECHANICAL PLANS

A. The Mechanical Drawings and Specifications shall form a set of Plans for the mechanical work. Neither the Drawings nor the Specifications shall be complete without the other. Any item shown on the Drawings or specified in the Specifications shall be considered as shown and specified on both.

B. Any questions regarding the intent of the Drawings or Specifications shall be brought to the Engineer's attention as soon as possible. If direction from the Engineer cannot be obtained due to time or communication limitations, the greater quantity, higher quality or condition most favorable to the Owner shall be assumed. Contractor shall provide all labor, materials, equipment, and miscellaneous items necessary for a complete and operational mechanical installation, as shown on the Drawings and called for in these Specifications.

C. Drawings:

1. Contractor shall familiarize themselves with Architectural, Civil, Structural and Electrical Drawings and Specifications. Coordinate all shafts, chases, furred spaces, suspended ceilings, locations of equipment, etc.
2. Mechanical Contractor shall coordinate routing of all piping and ductwork within soffits provided by the General Contractor. The Mechanical Contractor shall provide all soffiting required to cover installations not coordinated or specifically approved by the Architect and Engineer.

3. Mechanical Drawings are diagrammatic and are intended to show approximate location only. Placement of mechanical equipment and devices shall not interfere with locations or clearances of other trades' materials or equipment.
4. Contractor shall verify locations with architectural elevations.
5. Dimensions given on the Drawings shall take precedence over scaled dimensions. Dimensions, whether given in figures or scaled, shall be verified in the field.
6. Contractor shall verify that the equipment to be furnished under Contract will fit within the available space.
7. Notify the Architect and Engineer of any discrepancies between Electrical, Architectural and Mechanical Drawings.
8. Verify items such as door swings, window locations, casework, etc., before installing any mechanical equipment or devices. All devices conflicting with other trade's work due to lack of coordination shall be relocated at no additional cost to the Owner.

D. The following terms used in the Drawings and Specifications shall be defined as follows:

1. Contractor: Shall mean Mechanical Contractor or any of their Subcontractors.
2. Work: Shall mean labor and/or materials of the Mechanical Contractor or any of their Subcontractors.
3. Furnish: Shall mean purchase, submit for Engineer approval, coordinate with Contract Documents and deliver to site in new, undamaged condition.
4. Connect: Shall mean to bring mechanical service and/or control wiring to equipment, make all final connections, provide all necessary miscellaneous materials required and do final check out to ensure proper equipment connections.
5. Install: Shall mean to store as directed, protect from damage, set in place, connect, test and turn over to the Owner in full operating condition.
6. Provide: Shall mean furnish and install.

E. Electronic Design Files:

1. Mechanical electronic files prepared by Steen Engineering, Inc. for this Project are instruments of Steen Engineering, Inc. for use solely with respect to this Project. During the course of the implementation of the Project, and with Steen Engineering, Inc. approval, copies may be obtained of electronic files for the preparation of Shop Drawings. These electronic files shall not be used on other projects, for additions to this Project, or for completion of this Project by others. Any revisions, additions and/or deletions to these electronic files, either intentional or unintentional, shall be made at the full risk of the person(s) making such revisions, additions and/or deletions. Such person(s) shall hold harmless and indemnify Steen Engineering, Inc. of any and all responsibilities and liabilities.
2. Electronic files of Architectural floor plans, elevations, sections, etc, shall be requested directly from the Architect.

1.3 COORDINATION OF DRAWINGS

A. For typical or repetitive unit installations, contractor shall schedule an inspection with local and/or state AHJ to review a complete mock-up example installation and receive approval prior to proceeding with additional installations. Installation shall meet all code and manufacturer's service clearance requirements. Contractor shall coordinate installation and subsequent inspection with general contractor and any related trades.

B. Contractor shall submit a ¼-inch scale drawing to the Engineer indicating placement of all mechanical and electrical systems and equipment. Indicate proposed locations of all major equipment and materials, including but not limited to service equipment, exterior wall and foundation penetrations, fire-rated wall and floor penetrations, sizes and location of required concrete pads and bases, and mechanical/electrical equipment room layouts. This effort will require each trade to closely work together to produce a ¼-inch set of coordination drawings for each area of the building.

C. Coordinate scheduling and sequencing required for movement and positioning of large equipment into the building with all other Contractors to minimize impact on their work.

D. This Contractor shall provide any and all input required to complete these drawings.

1.4 ALTERNATES

A. **Refer to Architectural document for information on Alternates.**

1.5 MATERIALS AND EQUIPMENT

A. Materials:

1. All materials shall be new and of the type and quality specified herein.
2. Specific materials and equipment specified is intended to establish a minimum standard of required quality. Where specified materials and equipment fail to meet minimum standards of existing federal, state and local codes and ordinances, the governing codes and ordinances shall prevail.
3. The Contractor shall provide all minor miscellaneous materials necessary for the complete mechanical installation.
4. For materials and equipment specified by description only, the Contractor shall provide materials or equipment suitable for the purpose intended. These shall be in conformance with all governing codes, these Specifications and normal trade practice.
5. Supply materials and equipment to the site in original packages, containers or crates insofar as is practical. It shall be the Contractor's responsibility to schedule deliveries in accordance with the overall Project schedule. The Contractor shall closely coordinate all deliveries with other Contractors and the Engineer.
6. Provide for proper receipt, handling, storage, and protection from the elements for all materials and equipment to be used on this Project so as to effectively prevent damage or deterioration. Materials or equipment sustaining damage or undue deterioration from any cause whatsoever shall be replaced or repaired by Contractor.
7. The Contractor shall properly protect all equipment from damage during construction. Thoroughly clean all fixtures, equipment and other supplied materials. Make all necessary repairs and apply touch up paint prior to final inspection and contract close out.
8. All materials and equipment shall be listed by Underwriters' Laboratories, Inc. (UL). Materials and Equipment shall meet the UL requirements of each standard in every case where such a standard has been established for that particular type of material. Equipment shall be UL listed as an entire assembly or system.

B. Prior Approvals:

1. All requests for prior approvals must be received by the Engineer at least seven working days prior to bid date. Applications for prior approval shall be considered only from Contractors submitting bids on the Project. Contractors shall determine whether materials receiving prior approval are actually in accordance with details of the Specifications.
2. The Contractor shall be responsible for all deficiencies, design or performance related differences that may exist from the use of substituted products or equipment, including all additional labor and materials required to complete the work. **A substituted product refers to and includes any prior approved manufacturer or any manufacturer that differs from that equipment which is scheduled.** All dimensions and characteristics of substituted products shall be verified and coordinated with all affected trades and Subcontractors. Any required changes or modifications to the work of any other trade or Subcontractor incurred due to using accepted substituted products shall be coordinated and performed by this Contractor at no additional cost to the Owner.

1.6 SUBMITTALS

A. Submittal and Approvals:

1. Prepare drawings of fire protection systems indicating pipe sizes, pipe locations, head layouts and type, fittings, shutoff valves, equipment, fire department connections, etc. The design, hydraulic calculations and subsequent drawings shall reflect all modifications and extensions to existing piping equipment and head layout. Indicate elevations, slopes, floor and wall penetrations, drains, etc.
2. Submit to all Agencies having jurisdiction for approval. Submit to Owner insurance carrier for approval if required. After the documents have been approved by all reviewing agencies, submit the approved copies bearing stamps and/or signatures of Fire Marshal or agency having jurisdiction to the Architect for their use, before proceeding with installation.

1.7 WORKMANSHIP AND CONSTRUCTION PROCEDURES

A. Installation of all materials specified herein shall be performed in a neat and workmanlike manner by workers experienced and skilled in the trade. Only the best quality workmanship will be accepted.

B. The Contractor shall regularly clean their work area of debris. Removal of all Contractor generated debris and rubbish caused by their work shall be at the Contractor's expense.

C. Contractor shall coordinate with the Owner any interruptions necessary to existing systems prior to shut down.

D. Coordination:

1. Contractor shall give careful consideration to work of other Contractors on the Project and shall organize work as detailed in the Contractor's ¼" coordination drawings so as to not interfere with or delay the work of other trades.
2. This Contractor shall provide a complete installation manual to the Electrical Contractor for each piece of equipment requiring electrical power/control connections scheduled to be performed by the Electrical contractor. This shall be done prior to any rough-ins by the Electrical Contractor to insure proper power/control wiring has been provided. Notify the Engineer of any discrepancies between the installation manuals, the electrical plans and the mechanical specifications for each piece of equipment.
3. Contractor shall consult all Architectural, Structural and Electrical Drawings and Specifications that apply for correlating information.
4. Conflicts or interference with work of other trades shall be brought to the attention of the Engineer, in writing, before installation.
5. Should the Mechanical Contractor not follow above procedures and install work that interferes with work of other Contractors, the Mechanical Contractor shall make all necessary changes as directed by Engineer to eliminate the interference or conflict at the Mechanical Contractor's expense.

E. Protection of Equipment:

1. Until final acceptance of the work by the Owner, the Contractor shall be responsible for the safety, good condition, and protection from damage of all materials and equipment installed.
2. If, during shipment or installation, the finish of equipment becomes chipped or scratched, the Contractor shall touch up or refinish surfaces to match original finish.

F. The Contractor shall complete all safety forms required by General Contractor.

1.8 LICENSES, CODES AND FEES

A. The Contractor shall be a licensed Contractor in the State where the project is being constructed. The Contractor shall employ all Licensed Professional Tradesmen required for each type of work covered under these Drawings and Specifications.

B. The Contractor shall procure all necessary certificates and permits and pay all required fees. The Contractor shall pay all fees and installation charges by the utility company for the permanent services.

C. Codes and Ordinances: All work and materials shall meet the requirements of national, state and local codes and ordinances, in every respect. This requirement shall not relieve the Contractor from meeting the requirements of Drawings and Specifications that may be in excess of all codes and ordinances and not contrary to them.

D. Inspections: Regular inspections shall be requested by the Mechanical Contractor to meet all state and local requirements. Contractor shall furnish a certificate of final inspection and approval from all enforcement agencies to the Owner.

1.9 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver two sets of Operation and Maintenance (O&M) manuals to the Owner prior to final close out. O&M manuals shall consist of approved shop drawings, manufacturer's bulletins, equipment manuals, a list of manufacturers with telephone numbers for all equipment that contains replaceable parts, training videos and all other data covering the care, maintenance and operation of each piece of furnished equipment. O&M manuals shall be neatly bound in 3-ring binders, contain an index and section tabs and be labeled with the Project name.

B. Name, address, and telephone number of each Contractor installing equipment and systems, local representative for each item of equipment and each system. Table of contents shall correspond to the Specifications with the Section tab sheets placed before the respective Shop Drawings and operation and maintenance instructions.

1. Warranties for more than 1 year shall be included in appropriate section.
2. A maintenance and lubrication schedule shall include each motor, function, control location, fuse location, belt sizes type of lubricant, and rate of lubrication in accordance with manufacturer.
3. A filter maintenance schedule shall include filter size and quantity for each unit, located by room number.

1.10 OPERATING INSTRUCTIONS AND TESTING

A. The Contractor shall fully instruct the Owner in the operation of mechanical equipment prior to final close out. Contractor shall provide, without additional expense to Owner, services of competent instructors who will give full instruction in the care, adjustment, operation and maintenance of all mechanical systems provided by this Contractor to Owner's permanent employees. Instructor shall be thoroughly familiar with all parts of the installation that they are to give instructions and shall be trained in operating theory, as well as in practical operation and maintenance work. Factory trained instructors shall be employed wherever they are available. Instruction shall be given during regular work week and at a time just prior to the time the equipment is accepted and turned over to Owner for regular operation.

B. The Contractor or his representative shall provide a minimum of five days instruction period for Owner's personnel.

C. Contractor shall test all equipment installed under this Specification and shall demonstrate its proper operation to the Engineer. No equipment shall be tested or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment due to improper or ill-timed operation or testing shall be repaired, at Contractor's expense, before final inspection and acceptance.

1.11 WARRANTY

A. The Contractor shall guarantee all materials and equipment to be free of defects that may develop in any part of their work, caused by faulty workmanship, material or equipment failures, for a minimum of one year from the date of final completion of the Project or for as long as normal equipment manufacturer warranties are in effect from the date of final completion of the Project, whichever is later.

B. During the guarantee period, notification by letter, personal contact or telephone conversation of a problem with any mechanical system, shall cause the Contractor to respond within one week, making repairs or corrections. After all repairs and corrections are complete, the Contractor shall notify the Engineer.

C. During the guarantee period, the Contractor shall agree to provide 24 hour service on call for emergency.

Part 2. – PRODUCTS

N/A

Part 3. - EXECUTION

N/A

END OF SECTION 21 00 10

Part 1. – GENERAL

1.1 SUMMARY

A. The Contract for the fire protection installation must be a qualified Fire Protection Contractor regularly engaged in the installation of automatic fire sprinkler systems. Provide a fire protection technician certified with the National Institute of Certified Engineering Technicians (NICET level IV), to certify direct and supervise the work or if required by governing authorities, a registered professional engineer.

B. Codes and Standards:

1. NFPA compliance: Install fire protection systems in accordance with the latest edition of the NFPA. Verify with Local Inspector.
2. UL Compliance: Provide fire protection products in accordance with pre approval guide UL standards; provide UL label on each product.
3. Fire Department/Marshal Compliance: Install fire protection systems in accordance with local and/or state regulations of fire department or fire marshal.
4. Latest applicable State and Local Codes.
5. City Water Department Compliance: The water service connection and sprinkler system valve assembly shall comply with all City Water Department Requirements. Contractor shall coordinate with the Civil Engineer and the local utility to provide any post indicating valves required on site or on the building.
6. Provide a double check valve assembly ahead of the fire sprinkler connection.
7. Obtain all required approvals and permits. Permits shall be obtained from the city or municipality in which the system will be installed. If permits are not issued by the city or municipality, a permit shall be obtained from the State Fire Marshal.

C. Description of Work:

1. The sprinkler contractor is responsible for verifying and complying with State, City and Local municipalities any and all code requirements related to the fire sprinkler system.
2. Fire sprinkler contractor shall do a water flow and pressure test at the site of construction. Static pressure and residual pressure at given flow rated shall be obtained per NFPA 13, Chapter 9, Water Supplies.
3. Verify need if applicable to provide fire sprinkler protection in wood construction ceiling space with local inspectors. It is the sole responsibility of the sprinkler contractor to review all construction documents and verify with local inspectors the need for any special coverage, dry fire sprinkler protection for unheated spaces, pressure and flow requirements prior to submitting a bid.
4. If applicable include work for remodeled area. Refer to Demolition Specification Section 21 00 20.
5. Provide all labor and materials and perform all operations required in connection with the installation of the fire extinguishing systems.
6. For system notification, coordinate with Electrical Contractor for connection of signaling devices to Fire Alarm and Detection System, provided by electrical.
7. If applicable, Contractor shall verify kitchen exhaust hood fire suppression requirements with general contractor and kitchen design consultant. Contractor shall provide all water supply piping, sprinkler heads if required, valves, backflow protection, supervisory switches and related wiring.
8. Fire Sprinkler Contractor shall provide an approved grease hood fire suppression system. Fire Sprinkler Contractor shall coordinate with kitchen equipment supplier, exhaust hood and gas piping installer for proper installation of exhaust hood fire suppression system.
9. Food service equipment contractor shall provide a wet chemical and/or water fire suppression system. Fire Sprinkler Contractor shall coordinate with food service equipment contractor, exhaust hood installer and gas piping installer for proper installation of exhaust hood fire suppression system. Provide all additional equipment and accessories not being provided by the food service equipment supplier.

10. Fire Sprinkler Contractor shall provide a complete flow test of the existing fire system. Inspect condition of fire sprinkler system and all related fire sprinkler components. Fire Sprinkler Contractor shall notify Architect, engineer or Owner immediately of any existing or potential deficiencies that may require correction.
11. Modify existing fire sprinkler system serving the attached facility to accommodate the remodel areas.
12. Provide new fire sprinkler zone for the entire remaining existing area of the facility and the new addition.

D. Submittal and Approvals:

1. Prepare drawings of fire protection systems indicating pipe sizes, pipe locations, head layouts and type, fittings, shutoff values, equipment, fire department connections, etc. The design, hydraulic calculations and subsequent drawings shall reflect all modifications and extensions to existing piping equipment and head layout. Indicate elevations, slopes, floor and wall penetrations, drains, etc.
2. Submit to all Agencies having jurisdiction for approval. Submit to Owner insurance carrier for approval if required. **AFTER THE DOCUMENTS HAVE BEEN APPROVED BY ALL REVIEWING AGENCIES, SUBMIT THE APPROVED COPIES BEARING STAMPS AND/OR SIGNATURES OF FIRE MARSHAL OR AGENCY HAVING JURISDICTION TO THE ARCHITECT FOR THEIR USE, BEFORE PROCEEDING WITH INSTALLATION**.

Part 2. – PRODUCTS

2.1 GENERAL

A. The following is a general guideline on types of sprinkler heads and their recommended usage. Final design will need to be approved by local inspector and coordinated with Architect and Owner.

1. In all standard spaces with finished ceilings: Fully concealed sprinkler heads with only ceiling plate visible. Cover plate shall be factory finished in white.
2. Decorative lobbies, meeting rooms, executive offices: Fully concealed sprinkler heads with only ceiling plate visible. Cover plate shall be factory finished in white.
3. High areas with/finished ceilings: Exposed sprinklers, chrome finish with matching escutcheon.
4. All areas where piping will be exposed without finished ceilings: Exposed sprinklers, brass finish.
5. Areas exposed to pool areas, high humidity or weather: Corro-proof (polyester coated) sprinklers with matching escutcheon.
6. Extended coverage where possible on concealed piping in areas with finished ceilings.
7. Sidewall heads shall be recessed, white with white escutcheon for concealed piping.
8. Areas such as decks, canopies, small unheated interior spaces and attics enclosed entrances, elevator shafts, overhead doors vehicle parking areas, storage areas, loading docks, exhaust ducts, vestibules, coolers, freezers, entry way, etc, subject to freezing conditions, shall provide with a non-freeze system that meets NFPA standards and all state and local codes. Dry type sprinklers pendent, recessed concealed or horizontal sidewall, or fast response: All areas requiring more than two sprinklers shall be designed with complete dry pipe sprinkler systems.
9. Areas of high heat potential such as boiler rooms, furnace rooms and laundry rooms/closets shall use intermediate temperature class sprinklers.
   Provide black steel galvanized or 'Blaze Master' CPVC pipe and pipe fitting in accordance with the Codes and standards specified herein and as approved by the Authority Having Jurisdiction.
10. Dry sprinkler piping in attic shall be at a minimum schedule 10 black steel pipe with antimicrobical-coating with dry seal couplings and fittings. Locate air compressor in lower level parking area for dry sprinkler. Compressed air system shall be furnished with an air dryer General Air Projects day Series. Allied XL threadable pipe not allowed in dry system.
11. Threaded pipe, if used, shall be minimum Schedule 30 black steel with malleable black iron fittings. For 8" and larger and Schedule 40 black steel with malleable iron fittings for sizes less than 8".

Part 3. – EXECUTION

3.1 GENERAL

A. The design of the sprinkler system shall be dictated by the building construction and usage and as specified herein. Piping shall be concealed above suspended ceilings.

1. The design and method of installation of the fire protection work shall be in accordance with National Fire Protection Association Standards and National Fire Protection Association Standards and The Architect Codes that contain reference to or supplementary material on sprinkler systems along with the requirements of the Owner's insurance authority, the State, and the local Fire Department.
2. The sprinkler systems shall be hydraulically calculated.

B. Coordination:

1. The successful contractor must coordinate with the existing conditions, all other, building components, all new construction, and make all necessary modifications to the pipe routing before submitting for approval. Provide hydraulic calculations for all areas of the building including supplemental hydraulic calculations for all modification.
2. Additional compensation will not be allowed for modifications to the bid documents for additional sprinklers, coordination, or for additional hydraulic calculations.
3. Sprinkler head locations and all pipe routing shall be coordinated with all mechanical and electrical equipment and all structural and architectural components to avoid obstructions. All head locations shall be coordinated with architectural reflective ceiling plan.
4. This contractor shall carefully review all of the bid documents from all disciplines (architectural, structural, kitchen equipment, electrical and mechanical) and design the sprinkler systems to properly protect all areas of the facility.
5. The sprinkler system shall be installed in a manner that is aesthetically unobtrusive, with all sprinkler heads symmetrically aligned and centered in lay-in ceiling tile. System shall not interfere with existing equipment and building components (clocks, speakers, lights, etc.), and is not to be subject to damage by the building occupants.
6. **Prior to installing any mains or branches, the Sprinkler Contractor shall coordinate routing with all other trades to avoid conflicts. Contractor coordination details and sections shall be signed-off on by all Contractors prior to installation. Any installation that hinders another Contractor from installing their conduits, piping, ductwork, etc., shall be immediately removed to allow for their installation at no additional cost to the Owner or other Contractors.**
7. Contractor shall coordinate the routing of all sprinkler piping to maintain 8" minimum clearance from outside air ductwork and ducts or vents that communicate directly with the outdoors within a twenty foot distance from the outside wall penetration.
8. Prior to piping fabrication, the contractor shall submit to the architect, plans showing the routing of the sprinkler mains and branches. Approval of the architect must be obtained prior to fire sprinkler installation.
9. Sprinkler Contractor shall insulate all fire sprinkler piping within 15 feet of any exterior opening within the mechanical room with a minimum 1" fiberglass. Refer to plumbing insulation Specification Section 22 07 00.
10. Under no circumstances shall wet systems be installed in unheated spaces or attics.

END OF SECTION 21 10 00

Part 1. - GENERAL

1.1 SUMMARY

A. General and Supplementary conditions within Division 0 and 1 are hereby incorporated and become part of these Specifications, covering all work in Mechanical Division.

B. Before submitting a proposal on the project, the Contractor shall visit the site and familiarize themselves with the conditions and limitations affecting Mechanical Division work. No additional costs to the Owner shall be allowed for items verifiable during site visits.

C. Contractor shall provide sufficient workers and materials to keep pace with the construction schedule. Contractor shall place orders for equipment such that job progress is not slowed due to late delivery and shall confirm delivery dates with suppliers.

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7. Notify the Architect and Engineer of any discrepancies between Electrical, Architectural and Mechanical Drawings.
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E. Electronic Design Files:

1. Mechanical electronic files prepared by Steen Engineering, Inc. for this Project are instruments of Steen Engineering, Inc. for use solely with respect to this Project. During the course of the implementation of the Project, and with Steen Engineering, Inc. approval, copies may be obtained of electronic files for the preparation of Shop Drawings. These electronic files shall not be used on other projects, for additions to this Project, or for completion of this Project by others. Any revisions, additions and/or deletions to these electronic files, either intentional or unintentional, shall be made at the full risk of the person(s) making such revisions, additions and/or deletions. Such person(s) shall hold harmless and indemnify Steen Engineering, Inc. of any and all responsibilities and liabilities.
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1. All requests for prior approvals must be received by the Engineer at least seven working days prior to bid date. Applications for prior approval shall be considered only from Contractors submitting bids on the Project. Contractors shall determine whether materials receiving prior approval are actually in accordance with details of the Specifications.

1.5 SUBMITTALS

A. Within fifteen days after the award of the Contract, the Mechanical Contractor shall submit shop drawings on all major mechanical equipment to the Architect for approval. Shop Drawings shall be submitted by the Mechanical Contractor, not their Subcontractors. **Shop drawings shall be submitted separately per specification section. Multiple shop drawing sections received in a single submittal will be rejected.** These shop drawings shall cover such items as boilers, pumps, fittings, valves, plumbing fixtures, water heaters, water softeners, etc. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed and dated indicating Contractor review. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis. No equipment shall be released for shipment or installed prior to final approval by the Engineer.

B. The Engineer will review all Shop Drawings submitted and will retain one copy for record file.

C. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required for complete and functional systems. Submittals will be reviewed with the following actions:

1. "No Exception Taken" indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.
2. "Revise per Comments; No Resubmittal Required" indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without an increase in Contract Sum or Time.
3. "Revise and Resubmit" indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
4. "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.
5. "Copy Retained for Record Only" indicates the submittal is retained for reference only and is not reviewed for conformance with the Contract Documents.

D. If the Engineer rejects "Revise and Resubmit" or "Rejected"," the same section two times the engineer shall be compensated for additional reviews. Compensation will be incorporated by Change Order and will be deducted from the Contractor's application for payment. Contractor is responsible for all delays caused by the resubmittal process.

E. The Contractor shall be responsible for all deficiencies, design or performance related differences that may exist from the use of substituted products or equipment, including all additional labor and materials required to complete the work. **A substituted product refers to and includes any prior approved manufacturer or any manufacturer that differs from that equipment which is scheduled.** All dimensions and characteristics of substituted products shall be verified and coordinated with all affected trades and Subcontractors. Any required changes or modifications to the work of any other trade or Subcontractor incurred due to using accepted substituted products shall be coordinated and performed by this Contractor at no additional cost to the Owner.

F. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

G. Record Drawings: The Contractor shall provide and maintain an "As Built" set of bluelines on site, neatly notating routing, location or other field changes to the Contract Documents. Upon Project completion and prior to final close out, turn the "As Built" drawings over to the Owner. Provide a detailed transmittal indicating each sheet and other information turned over to the Owner and acquire their representative's signature. This information shall be included at the project close out.

1.6 WORKMANSHIP AND CONSTRUCTION PROCEDURES

A. Installation of all materials specified herein shall be performed in a neat and workmanlike manner by workers experienced and skilled in the trade. Only the best quality workmanship will be accepted.

B. The Contractor shall regularly clean their work area of debris. Removal of all Contractor generated debris and rubbish caused by their work shall be at the Contractor's expense.

C. Contractor shall coordinate with the Owner any interruptions necessary to existing systems prior to shut down.

D. Coordination:

1. Contractor shall give careful consideration to work of other Contractors on the Project and shall organize work as detailed in the Contractor's ¼" coordination drawings so as to not interfere with or delay the work of other trades.

2. This Contractor shall provide a complete installation manual to the Electrical Contractor for each piece of equipment requiring electrical power/control connections scheduled to be performed by the Electrical Contractor. This shall be done prior to any rough-ins by the Electrical Contractor to insure proper power/control wiring has been provided. Notify the Engineer of any discrepancies between the installation manuals, the electrical plans and the mechanical specifications for each piece of equipment.
3. Contractor shall consult all Architectural, Structural and Electrical Drawings and Specifications that apply for correlating information.
4. Conflicts or interference with work of other trades shall be brought to the attention of the Engineer, in writing, before installation.
5. Should the Mechanical Contractor not follow above procedures and install work that interferes with work of other Contractors, the Mechanical Contractor shall make all necessary changes as directed by Engineer to eliminate the interference or conflict at the Mechanical Contractor's expense.

E. Protection of Equipment:

1. Until final acceptance of the work by the Owner, the Contractor shall be responsible for the safety, good condition, and protection from damage of all materials and equipment installed.
2. If, during shipment or installation, the finish of equipment becomes chipped or scratched, the Contractor shall touch up or refinish surfaces to match original finish.

F. The Contractor shall complete all safety forms required by General Contractor.

1.7 LICENSES, CODES AND FEES

A. The Contractor shall be a licensed Contractor in the State where the project is being constructed. The Contractor shall employ all Licensed Professional Tradesmen required for each type of work covered under these Drawings and Specifications.

B. The Contractor shall procure all necessary certificates and permits and pay all required fees. The Contractor shall pay all fees and installation charges by the utility company for the permanent services.

C. Codes and Ordinances: All work and materials shall meet the requirements of national, state and local codes and ordinances, in every respect. This requirement shall not relieve the Contractor from meeting the requirements of Drawings and Specifications that may be in excess of all codes and ordinances and not contrary to them.

D. Inspections: Regular inspections shall be requested by the Mechanical Contractor to meet all state and local requirements. Contractor shall furnish a certificate of final inspection and approval from all enforcement agencies to the Owner.

1.8 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver two sets of Operation and Maintenance (O&M) manuals to the Owner prior to final close out. O&M manuals shall consist of approved shop drawings, manufacturer's bulletins, equipment manuals, a list of manufacturers with telephone numbers for all equipment that contains replaceable parts, training videos and all other data covering the care, maintenance and operation of each piece of furnished equipment. O&M manuals shall be neatly bound in 3-ring binders, contain an index and section tabs and be labeled with the Project name.

B. Name, address, and telephone number of each Contractor installing equipment and systems, local representative for each item of equipment and each system. Table of contents shall correspond to the Specifications with the Section tab sheets placed before the respective Shop Drawings and operation and maintenance instructions.

1. Warranties for more than 1 year shall be included in appropriate section.
2. A maintenance and lubrication schedule shall include each motor, function, control location, fuse location, belt sizes type of lubricant, and rate of lubrication in accordance with manufacturer.

3. A filter maintenance schedule shall include filter size and quantity for each unit, located by room number.

1.9 OPERATING INSTRUCTIONS AND TESTING

A. The Contractor shall fully instruct the Owner in the operation of mechanical equipment prior to final close out. Contractor shall provide, without additional expense to Owner, services of competent instructors who will give full instruction in the care, adjustment, operation and maintenance of all mechanical systems provided by this Contractor to Owner's permanent employees. Instructor shall be thoroughly familiar with all parts of the installation that they are to give instructions and shall be trained in operating theory, as well as in practical operation and maintenance work. Factory trained instructors shall be employed wherever they are available. Instruction shall be given during regular work week and at a time just prior to the time the equipment is accepted and turned over to Owner for regular operation.

B. The Contractor or his representative shall provide a minimum of five days instruction period for Owner's personnel.

C. Contractor shall test all equipment installed under this Specification and shall demonstrate its proper operation to the Engineer. No equipment shall be tested or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment due to improper or ill-timed operation or testing shall be repaired, at Contractor's expense, before final inspection and acceptance.

1.10 WARRANTY

A. The Contractor shall guarantee all materials and equipment to be free of defects that may develop in any part of their work, caused by faulty workmanship, material or equipment failures, for a minimum of one year from the date of final completion of the Project or for as long as normal equipment manufacturer warranties are in effect from the date of final completion of the Project, whichever is later.

B. During the guarantee period, notification by letter, personal contact or telephone conversation of a problem with any mechanical system, shall cause the Contractor to respond within one week, making repairs or corrections. After all repairs and corrections are complete, the Contractor shall notify the Engineer.

C. During the guarantee period, the Contractor shall agree to provide 24 hour service on call for emergency.

Part 2. – PRODUCTS

N/A

Part 3. - EXECUTION

N/A

END OF SECTION 22 00 10

SECTION 22 00 50
BASIC MATERIALS AND METHODS

Part 1. - GENERAL

1.1 SUMMARY

A. Work included under this Division shall consist of furnishing labor and materials necessary for the installation of the work called for under the Mechanical, Fire Sprinkler Protection, Temperature Control and Mechanical Test & Balance contracts as listed in the Instruction to Bidders, as specified, and as shown on Drawings to provide a complete, operable and approved system.

1.2 REFERENCES

A. The following is a partial list of related standards:

1. American National Standard Institute (ANSI).
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Sanitary Engineers (ASSE).
5. American Society for Testing and Materials (ASTM).
6. American Water Works Association (AWWA).
7. Cast Iron Soil Pipe Institute (CISPI).
8. Manufacturer's Standardization Society (MSS of the Valve and Fittings Industry, Inc.).
9. National Electrical Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA).
11. Plastic Pipe Institute (PPI).
12. Steel Tank Institute (STI).

1.3 QUALITY ASSURANCE

A. Where equipment is specified by manufacturer, brand name or catalog number, this shall establish the standard of quality and style of the product to be provided under the Contract.

B. Where two or more units of the same kind of equipment are required, they shall be products of a single manufacturer. Mixing and matching of various manufacturers' like or similar components shall not be permitted.

C. The Contractor shall field verify and inspect existing buildings for connections to existing systems, equipment, and materials designated, on Drawings or in Specifications, to be used.

D. The Contractor shall have full responsibility of component parts of the mechanical system to ensure that new equipment, integrated with existing equipment and systems, will perform and operate in accordance with requirements of the Specifications without excessive or unusual service or maintenance requirements.

E. The Contractor shall be responsible for verifying locations of such things as piping, ductwork, equipment, door swings, heights of cabinets and counters, etc., prior to the installation of any mechanical equipment. Installed mechanical work that interferes with the work of other trades shall be relocated by the Mechanical Contractor at no additional cost to the Owner.

F. Contractors shall coordinate with all other trades and install their systems in the space provided/coordinated within the structure. Install systems and materials for ease of maintenance. Equipment arrangements shall

provide at least the minimum clearances as recommended by equipment manufacturer to facilitate proper maintenance and servicing of system. Deviations in minimum clearance requirements shall be permitted only upon prior written authorization from the Architect/Engineer.

G. For project sites higher than 2000 feet or more above sea level, gas fired equipment shall be modified to maintain specified output.

Part 2. - PRODUCTS

2.1 FIRE BARRIER PENETRATION SEALING SYSTEMS:

A. Approved Manufacturers: 3M, Transco Products, Nelson Flameseal Systems, Tremco, Inc., Hilti.

B. Firestopping materials shall conform to local building code requirements and shall be tested according to UL 1479 and ASTM-E84 for through-penetration firestop systems.

C. Firestopping materials shall be furnished by a supplier who specializes in the selection and furnishing of firestopping materials for building systems.

D. Submit shop drawings including a penetration protection schedule which lists each fire resistive construction type for this project, its fire rating, item penetrating and insulation (if any) UL through-penetration firestop systems number, manufacturer and model numbers. Include installation diagrams and product data sheet.

E. Contractor shall submit all fire stopping methods to Local Authorities for approval. Provide copies of all approved fire stopping methods to the Engineer. Seal all penetrations and sleeves through floors and fire walls with high temperature, fire rated sealant. Fire stop material shall be 3M brand Fire Barrier Penetration System. In lieu of type system described above, modular component system shall be ProSet System Inc. may be utilized. Install the appropriate concrete or wood penetration system to comply with Code.

2.2 WALL, FLOOR, AND CEILING OPENINGS

A. General Requirements:

1. Contractor shall be responsible for exact sizes and locations of chases and openings required for mechanical work.

B. Chases and Openings:

1. General Contractor shall leave chases and openings in walls, floors, ceilings, and partitions where shown on Drawings or otherwise necessary to receive mechanical work. It is this contractor’s responsibility to coordinate sizes and locations prior to framing, pouring or setting of precast.

2.3 SLEEVES

A. General Requirements:

1. Provide sleeves in conjunction with water tight piping passing through concrete or masonry walls, partitions, and slabs. Provide sleeves in mechanical equipment rooms and chases to prevent water flooding from floor to floor in addition to separating piping from building structure.
2. Sleeves shall extend 3” beyond the full thickness of walls and shall be at least 2 pipe diameters larger than or 2” larger than ducts piping passing through. Where piping with covering is installed, a 1” shall

be provided between outside of pipe covering and inside surface of the sleeve.

B. Pipe Sleeves:

1. Exterior Walls: Sleeves shall be standard weight steel pipe. Install sleeves in exterior walls and floors below grade with approved caulking between sleeves and piping to make it waterproof. Plastic sleeves shall not be used.
2. Floors: Sleeves shall be standard weight steel pipe. Vertical pipe sleeves through floors shall have space between pipe and sleeve packed with an approved fire stop material flush with top of sleeve to make a watertight and fire rated joint.
3. Interior Sleeves: Sleeves shall be standard weight steel pipe. Piping through walls of adjacent rooms shall have soundproof packing in non-rated walls and an approved fire stop material in fire rated walls.
4. Fire Rated Wall and Floor Openings: Piping passing through fire rated walls and floors shall be provided with an Underwriter's Laboratories, Inc. listed pipe and pipe sleeve assembly. Pipe and pipe sleeve assembly shall meet or exceed fire rating of wall and floor which the pipe passes through.
5. Contractor shall provide all sleeves required through footings, foundation walls and floors. Underground water services as indicated on plans shall be sleeved with schedule 40 PVC sleeving. Sleeve to be (1) size larger than the pipe it serves. Extend sleeves 0'-3" beyond penetration. Coordinate with Structural Engineer.

2.4 ACCESS PANELS

A. The Contractor shall provide means of access for all equipment valves and fittings specified to comply with Local Code. Furnish wall and ceiling access panels to the General Contractor for installation. Access doors and panels required within rated separations shall carry the appropriate rating. Conform to Division 8 access panel specifications. Contractor to provide separate per unit price per access panel for pricing purposes.

Part 3. - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. On-Site Review: Contractor shall visit site to become thoroughly acquainted with existing conditions of site and services.
2. Existing Active Services: When encountered during construction, Contractor shall protect, brace or support pneumatic tubing, existing active sewers, water, gas, ductwork, or other services, for proper execution of Work.
3. Inactive Services: If encountered during construction, Contractor shall cap or plug inactive pipes, ducts, and temperature control tubing or wiring at no additional cost to Owner.
4. Responsibility: Liability for repairs or replacement of damaged or defective materials, including, but not limited to, property damage resulting from negligence or other causes, shall be the Contractor's sole responsibility until work has been accepted by Architect/ Engineer and Owner.

3.2 PREPARATION

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A. Protection: After delivery, and before and after installation, equipment shall be protected against theft or damage.

1. Contractor shall protect plumbing fixtures, metal heating enclosures and other equipment and all baked enamel or glazed surfaces from damage by covering or coating as recommended in Bulletin, "Handling

and Care of Enameled Cast Iron Plumbing Fixtures", issued by Plumbing Fixture Manufacturers Association or by other methods approved by Architect/Engineer.

2. Coat polished or plate metal parts with vaseline immediately after installation. Protect equipment outlets, pipe and conduit openings with temporary plugs, caps or burlap to prevent filling with construction dirt.

3.3 EXCAVATION AND BACKFILL

A. Excavation: Contractor shall perform excavation boring, drilling, back filling and compaction at required depth for installation of work indicated or specified.

1. Excavated material not required or not suitable for backfilling shall be removed from site.
2. Protect excavation by grading and pumping to keep space clear of water during construction.
3. Provide shoring and sheeting as necessary for protection of work and safety of personnel. Protect bottom of excavation from frost.
4. Excavation in rock shall be 8-inch below invert of pipe to be installed and shall be backfilled to a depth of 8-inch with clean, washed sand before pipe installation.
5. Excavation terminating in unstable or organic material at pipe invert elevation shall be continued to 30-inch below pipe invert elevation and backfilled with pit run gravel to pipe invert. Soil boring reports are available for inspection at Architect's office.
6. Pipe installation in backfilled areas shall not occur until backfill is 2 feet above pipe invert, at which time backfill shall be excavated to proper depth, pipe installed, and backfill replaced as specified.
7. All lines are to be properly capped to prevent the entrance of dirt or any other foreign matter. All debris and water shall be removed from the trench prior to final installation. Properly protect piping or ductwork until backfilling can be performed. Inspection of all installations by Local Inspection Authorities shall be completed prior to backfilling.

B. Backfilling Under Floors and Slabs: Backfill areas below concrete slabs on grade in horizontal layers not to exceed 8-inch in depth and compact with approved equipment until dry density is not less than 95 percent of Standard Proctor Density.

1. Backfill material shall be pit run gravel or coarse sand free of rubbish, compacted and leveled to receive slab. If natural earth is of similar structure with same material as specified above, no additional material will be required. Fill to raise subgrades to required elevation shall be accomplished as specified above.
2. Materials and methods of compaction shall be approved by Architect/Engineer before start of work.
3. Areas not below concrete or asphalt slabs and footings shall be backfilled with suitable excavated material, free of debris and rubbish.
4. Carefully backfill to a point 6” above piping or ductwork and thoroughly tamp. Complete backfilling in 8” lifts and compact each layer to 98% standard proctor density. Restore surface to its original condition, i.e. grass, concrete, blacktop, etc.
5. Contractor shall pay costs for testing of compacted backfill by an approved testing laboratory when tests are requested by Architect/Engineer.

C. Backfilling Outside: Backfill excavations below finished grades with materials similar to that removed in excavation, free from rubbish or other unsuitable material. Place backfill and compact to prevent settling.

1. Backfilling shall be done to finished grades indicated on Drawings. If no finished grading is done in excavated areas, Contractor shall backfill to existing grades and restore surface to original condition.
2. Compaction over ditches less than 3 feet in width and around walls and columns shall be done by the use of mechanical hand compactors.
3. Contractor shall pay costs for testing of compacted backfill by an approved testing laboratory when tests are requested by Architect/Engineer.

D. Pavement, Curb, and Sidewalk Replacement:

1. Contractor shall be responsible for the replacement of existing street pavement, curbs and sidewalks removed or damaged by Contractor or related subcontractors.
2. Make necessary arrangements to perform such repairs and pay incurred costs in connection with said repairs, including amount in Bid.

3.4 CUTTING AND PATCHING

A. Cutting and patching shall be held to practical minimum consistent with good construction practice by properly locating and leaving sleeves and boxes, or notifying General Contractor of openings, where required, as construction progresses. All cutting and patching shall be done with the prior approval of the Architect/Engineer.

1. Necessary cutting and patching of walls, floors, partitions and ceilings, for the proper installation of work under this Contract, shall be the sole responsibility of this Contractor. Perform cutting and patching in such a manner as to leave no visible trace and to return the part affected to the condition of undisturbed work. Cutting and patching shall be performed by men experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted.

B. Pavements and Concrete: Cutting shall be accomplished by saw cutting a minimum of 1 ½-inch deep prior to jack hammering. Contractor shall bore below the surface where indicated on Drawings or where required by Architect/Engineer.

C. Repair: Patch pavements and concrete to match existing conditions. All labor and materials required to replace and repair sections cut or damaged shall be furnished and installed by this Contractor.

3.5 INSTALLATION

A. Connection to Equipment Specified: Provide material and labor required to connect to the mechanical system of fixtures and equipment having mechanical connections and which are specified in other Sections or Divisions of the Specifications or furnished by Owner.

1. Provide piping supply connections with shut-off valves.
2. Drainage connections shall be properly trapped and vented.

B. The Mechanical Contractor shall provide concrete pads for all floor mounted equipment. Pads shall be 4” thick and extend a minimum of 2” beyond equipment.

C. Mechanical Contractor shall provide angle iron stands for all gas fired equipment located on the same level or below any enclosed parking garage floor where the mechanical room opens to that same level. Stands shall elevate burners above 18” to comply with Local Code. This includes all water heaters, boilers, etc. Verify exact requirements with the Local Inspector prior to performing any fabrication.

D. Floor, Wall and Ceiling Plates:

1. Where uncovered exposed pipes pass through floors, walls or ceilings in finished rooms and inside casework, fit with approved type chrome plated metal plate.
2. Plastic escutcheon plates shall not be permitted.

E. Mechanical Systems Painting: Exposed supporting iron and steel work, bare pipe, fittings, hangers, and supports shall be wire brushed, washed with mineral spirits to remove dirt and grease, and painted with one coat of metal primer followed by two finish coats of battleship gray paint.

F. Concealed Equipment location: Location of motor operated equipment, furnished under this Contract, installed above ceiling shall be identified by placing a color coded thumb tack (or adhesive applied dot) in the ceiling directly below item noted. Identification colors shall be as follows:

1. Pumps: Green
2. Control Valves: Yellow
3. Shut-off Valves: Orange

G. Chlorination of Domestic Water Lines: Contractor shall clean entire domestic water system in building, shall disinfect system in strict accordance with governing codes and State Health Department Requirements, and shall flush entire system clean with potable water.

1. The piping system shall be flushed with clean, potable water until no dirty water appears at the points of outlet.
2. The system or part thereof shall be filled with a water-chlorine solution containing at least 50 parts per million of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours.
3. The system or part thereof shall be filled with a water-chlorine solution containing at least 200 parts per million of chlorine and allowed to stand for 3 hours.
4. Following the allowed standing time, the system shall be flushed with clean potable water until no chlorine remains in the water coming from the system.
5. Contractor shall provide written certification to Architect/Engineer that chlorination and flushing of domestic water system has been completed.

H. Filtration: At time of substantial completion, and prior to turning equipment over to Owner, Contractor shall install a complete set of unused, clean filters in each type of unit supplying filtered air to the building.

3.6 IDENTIFICATION

A. Exposed Piping: Bare and insulated, exposed new piping in Boiler Room, Mechanical Rooms, and unfinished rooms shall be identified with labels, painted on using metal stencils. Stencils shall have 1-inch high letters and shall include a directional arrow 3-inch long by 1/2-inch wide, indication direction of flow. Color of stenciling shall be black lettering on a yellow background.

1. Labels shall be located at each change in direction of pipe runs and at intervals not to exceed 20 feet.
2. Setmark snap-on pipe markers by Seton Nameplate Corporation or snap-on pipe markers by W. H. Brady Company, which are similar to above stencil description shall be acceptable.

B. Concealed Piping: Bare and insulated new piping running in ceilings and soffits shall be identified with labels painted on using metal stencils. Each stencil shall have 1-inch high letters and shall include a directional arrow 3-inch long by 1/2-inch wide indicating direction of flow. Color of stenciling shall be black lettering on a yellow background.

1. Labels shall be located at each change in direction of pipe runs and at intervals not to exceed 20 feet.
2. Labels shall be located on each side of wall, partition and floor penetrations.
3. Setmark snap-on pipe markers by Seton Nameplate Corporation or snap-on pipe markers by W. H. Brady Company, which are similar to above stencil description shall be acceptable.

C. Pipe Markers: Contractor shall label the piping as follows:

1.	Domestic Cold Water	CW
2.	Domestic Hot Water	HW
3.	Domestic Recirculating Hot Water	RHW
4.	Natural Gas	G
5.	Rain Water Leader	RWL
6.	Fire Sprinkler	FIRE

D. Equipment: All scheduled equipment under this Division shall be identified with stamped labeled placards matching the scheduled identification tags and adhere directly to the equipment.

E. Controls: Controls and switches furnished under this Division shall be clearly labeled and identified.

3.7 CLEANING

A. Housekeeping, Cleaning and Storage: Remove from the building and site, scrap material, temporary building, packaging material, miscellaneous debris and dirt on a regular schedule and in accordance with Architect/Engineer's direction, to maintain building in a reasonably clean, workable condition during construction.

1. Cutting oil and steel shavings shall be caught in a suitable container to ensure final finish material in building will not be marred or damaged.
2. Upon completion of work and before final inspection, Contractor shall remove plaster, paint, rust, stickers, and shipping tags from installed equipment.
3. Clean foreign matter from installed equipment and remove dirt and debris, in connection with work, from building.

3.8 PRE-OPERATIONAL SYSTEM CLEANOUT

A. Pre-Cleaning Chemicals: New piping systems and appurtenances shall be cleaned with a one percent solution of Ferrosol 345, neutral pH cleaner, to remove any iron deposits, oil-based coatings, mill scale and construction residues.

1. Follow manufacturers' directions regarding equipment.

END OF SECTION 22 00 50

SECTION 22 05 00
TESTING AND BALANCING

Part 1. – GENERAL

1.1 SUMMARY

A. Section includes testing, adjusting and balancing, plumbing and natural gas systems, measurement of final operating condition systems, sound measurement of equipment and vibration measurement of equipment during operating conditions.

1.2 REFERENCES

A. NEBB (National Environmental Balancing Bureau). Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

B. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

C. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

D. Provide reports in bound manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

E. Include detailed procedures, agenda, sample report forms and a copy of NEBB Certificate of Conformance Certification prior to commencing system balance.

Part 2. - PRODUCTS

N/A

Part 3. - EXECUTION

3.1 GENERAL

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Domestic Water Systems:

    a. Pumps are rotating correctly.
    b. Proper strainers are clean and in place or in normal positions.
    c. Service and balance valves are open.

B. Test and start-up all equipment supplied under this contract.

1. Provide all reports necessary to assure the Engineer and Owner that all functions of each piece of equipment have been thoroughly evaluated and deemed operable as designed.
2. Ensure recorded data represents actual measured or observed conditions.
3. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops.
4. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
5. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.2 WATER SYSTEM PROCEDURE

A. Plumbing:

1. Defects: Contractor shall be responsible for defects which develop in the systems caused by faulty workmanship, material or equipment and shall replace any such faulty workmanship, material or equipment during a period of 1 year from date of final acceptance. Acceptance of the work shall not waive the guarantee.
2. Approval: Inspect and test plumbing work for approval by Architect/ Engineer or a designated representative.
3. Tests: Tests shall be made in the presence of the Architect/Engineer or a designated representative. Tests shall be made, at Contractor's expense, and a certification furnished to the Architect/Engineer stating that satisfactory tests have been made.
4. Piping: Tests of piping systems, except final test of complete systems, shall be made before piping is covered or connected to fixtures and equipment. Tests required shall not be less than as specified in the following paragraphs, unless designated otherwise in specific sections.

    a. Storm and sanitary, waste and vent piping, inside the building shall be tested with air at 5 psi gauge pressure and shall hold this pressure for 15 minutes without addition of more air. Provide final test with fixtures including flammable waste trap, grease trap, floor and roof drains in place with 1" W.G. air pressure.
    b. Test Domestic water piping, tanks, valves and fittings with hydraulic pressure of 100 psig for a period of 24 hours.
    c. Test natural gas piping per 2018 International Fuel Gas Code, Chapter 4, Section 406.

        1) Piping shall be tested at a pressure of 25 psig minimum for 30 minutes.

3.3 START-UP AND COMMISSIONING

A. Following substantial completion, contractor shall return to the site on a quarterly basis including four (4) balancing/commissioning sessions. Commissioning shall consist of rebalancing domestic water systems to the extent required to verify proper operation of all system components and controls. Balancing contractor shall coordinate with all trades including controls contractor to make required adjustments.

END OF SECTION 22 05 00

SECTION 22 05 29
SUPPORTS AND ANCHORS

Part 1. – GENERAL

1.1 SUMMARY

A. Section Includes: Include labor, materials, equipment, and accessories to furnish and install supports, anchors, and seals for equipment, materials, and related work specified elsewhere.

1.2 SUBMITTALS

A. Submit shop drawings for all equipment provided under this section. Drawing shall include registered Structural Engineers Seal where required.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Guides manufactured by: Metraflex, Hyspan, Flexweld- Keflex, Flexicraft, Flexonic, Anvil International.

B. Supports and hangers manufactured by: B-Line, Grinnell, Michigan, Anvil International, NIBCO, National, Empire Industries and L.C. Penner.

C. Expansion anchors manufactured by: Hilti, Simpson, Illinois Tool Works.

D. Power driven fasteners manufactured by: Hilti, Simpson, Norbord.

E. Firestop material for penetration or construction manufactured by: 3M MP-1 Moldable Putty, Flamseal Putty, 3M Caulk CP-25WB, Dow Corning 3-6548 RTV Foam, Tremco.

2.2 PIPING INSERTS AND HANGERS

A. Hanger Supports and Inserts: Piping suspended from construction above shall be hung from concrete inserts in concrete construction, toggle bolts and rod coupling on prefabricated, reinforced hollow concrete slabs, I-beam clamps or hanger rod, washer and two nuts on bar joist construction. On other types of building construction a field approved type clamp or bracket shall be used.

B. Hangers, Clamps, and Collars: Piping shall be suspended from inserts, clamps or brackets by means of clevis type or roller type hanger and solid steel rods spaced not more than 10 feet apart on steel pipe and pipe rings spaced not more than 8 feet apart on copper pipe. Support vertical cast iron and steel pipes at each floor by heavy wrought steel riser clamps or collars. Support vertical copper pipes at each floor by riser clamps with asphalt felt lining under couplings placed in vertical copper piping. Support piping 4-inches and larger by single pipe roller assemblies with adjustable socket.

C. Support horizontal piping subject to expansion with adjustable roller hangers.

2.3 ANCHORS AND GUIDES

A. Anchor Fabrication: Construct anchors using I-beams, channel iron, tees, or angles or a combination thereof.

1. Tee iron shall be welded to side, top or bottom of pipe. Angle iron diagonal bracing shall be welded or

bolted to tee iron and wall or ceiling. Anchors shall be welded or double clamped to pipe.

2. Where a group of pipes are to be anchored, but cannot be secured as above, the pipes shall be anchored to an assembly constructed of I-beams, channels or both, which shall be anchored to the building structure.

B. Guides: Guides shall be fabricated from carbon steel. Housing shall be of two piece design, connecting upper and lower housing with two bolt or by welding, after spider and pipe have been set in lower half of housing. Lower housing shall have two legs for support running the full length of housing. Two piece spider clamp shall be fastened around pipe (or pipe with insulation) with two bolts forming six legs which guide pipe inside housing. Legs may be on bottom, side or top of unit for bolting to floor or top of beam, wall or underside of structure.

1. Insulation inside the spider clamp shall be hydrous calcium chloride with vapor barrier from entering and exiting pipe continuing through the clamp.
2. Unit shall be furnished with a factory baked enamel finish.

2.4 BRACKETS, BRACES AND SUPPORTS

A. General Requirements: Furnish and install brackets, braces or reinforcing angles in partitions not sufficient in themselves to support piping or plumbing fixtures or other wall hung equipment included in this Specification. Bolts shall extend through walls, finished on opposite side, or one wall of a pipe chase, and shall be not less than 3/8-inch brass bolts with 3-inch cut washer on opposite side of wall.

B. Fasteners: Bolt head and washer shall be concealed under wall finish on finished walls. On hollow walls not finished on opposite sides, use toggle bolts. On solid walls use 3/8-inch brass bolt extending 4 inches into wall secured with molten lead poured around bolt. Secure floor mounted wall closets with 5/16-inch brass bolt with chrome plated cap, nut, and washer.

C. Support Racks: Support tunnel piping on Unistrut, Bee-Line, pipe racks assembled as indicated by details on Drawings. Unistrut steel products shall have prime bonderized finish coating.

D. Pipe Drop Supports: Brace exposed pipe drops to pumps and other equipment with angle iron framework to relieve strain on flexible connectors or equipment and anchor piping to eliminate movement.

PART 3. - EXECUTION

3.1 HANGER INSTALLATION

A. Hanger Location: Locate hangers to properly support pipes and ducts; relieve strain on pipe, duct, and fittings; and allow for ample expansion and contraction. Piping smaller than 4-inch size shall be hung with individual ring hangers where space prevents use of other type hangers.

1. Piping shall not be hung from the roof deck.
2. Except where trapeze hangers are used to support piping, all piping shall be individually supported. Do not support ducts or pipes from other pipes, ducts or equipment or conduit.
3. Place a hanger within one foot of each horizontal elbow.

B. Domestic Water Piping Support: Suspend and support domestic water piping as indicated above, except domestic water piping shall be supported over piping insulation saddles as indicated in Section 22 07 00 with no break in insulation vapor barrier.

C. Anchor Piping in Chases: Copper piping in pipe chases behind plumbing fixtures shall be anchored to waste and vent piping with angle iron and U-clamps with asphalt felt lining under clamps.

D. Trapeze Hangers: Groups of pipes at the same elevation and close together may, at the option of the Contractor, be supported by suitable trapeze hangers suspended from inserts, clamps or brackets by solid steel rods.

E. Bell and Spigot Support: Support bell and spigot pipe not underground from above hangers at each joint in the pipe run.

F. "No Hub" Pipe Support: "No hub" soil pipe runs shall have two hangers per joint, one on each side of joints.

G. Plastic Piping Support: Support plastic piping from above inserts, clamps or brackets with Grinnell Figure 269 adjustable ring hanger on 32-inch centers where conveying waste from dishwashers or similar hot water wastes it shall be supported on continuous metal or wood strips for its entire length.

H. Thoroughly and substantially support all piping from approved hangers. The design, selection, spacing and application of horizontal pipe hangers, supports, restraints, anchors and guides shall be in accordance with applicable standards. The power Piping Code ANSI B31.1 shall take precedence over the MSS SP-69 Standard.

3.2 PIPE HANGERS AND SUPPORT INSTALLATION

A. Support horizontal steel and copper piping with maximum spacing between supports as noted.

Nominal Pipe Size (In.)	Distance Between Supports (Ft.)	Hanger Rod Diameter (In.)
½ & ¾	6	3/8
1 to 1 ½	8	3/8
2 & 2 ½	10	½
3 & 4	12	5/8
5 to 12	14	7/8

B. CPVC pipe or tubing shall have a maximum hanger spacing of every three feet for one inch and smaller and every four feet for sizes 1-1/4 inch and larger.

C. Provide additional supports for valves or other concentrated loads between supports.

D. Install hangers to provide minimum ½ inch clear space between finished pipe insulation and adjacent work.

E. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Provide hanger spreaders on hangers for pipes 4 inches and larger.

3.3 ANCHORS AND GUIDES INSTALLATION

A. Boiler Room: Provide adequate anchors and guides on domestic piping in Mechanical Rooms and Boiler Room to prevent swaying of pipe.

B. Anchors: Install anchors approximately centered in every 70-foot run, blind ends, changes in pipe direction, except when elbow is used to absorb expansion and at major branch connections.

1. An expansion joint or loop or expansion elbow, but not more than one, with appropriate guides, shall be installed between each pair of anchors.

2. If expansion loops are installed in same line with expansion joints, the section containing the loop shall be isolated from the section containing the joint by means of an anchor.

C. Guides: Install 4 guides, 2 on each side, for each expansion loop or joint. On each side, install one pipe guide a maximum of 4 pipe diameters from expansion loop or joint and one pipe guide a maximum of 14 diameters from the first guide.

3.4 INSULATION PROTECTION AT PIPE HANGERS

A. Shield insulation shall be galvanized steel, 16 gauge for piping smaller than 4 inches, 14 gauge for piping 4 inches and larger and shall span an arc of 180 degrees. Lengths of shields shall be as follows:

Pipe Size	Shield Length
Up to 6”	12”
8”-12”	16”

B. On cold water piping install a wood block at hanger points. Insulation jacketing shall be sealed where cut to install the block.

C. Provide offsets and transitions to plumbing and piping due to existing structure and trades work.

3.5 EXPANSION JOINTS

A. Provide Metraflex, Model HP axial expansion compensators rated for minimum 150 psi working pressure. Acceptable Manufactures: Flexicraft, Hyspan, Duraflex, Microflex, Flexonics.

B. Provide additional expansion joints and offsets for excessive expansion in plastic piping.

C. Installation of piping and expansion products shall be in strict accordance with manufacturer’s instructions.

D. No plastic piping vertical horizontal storm or sanitary stack may exceed 30 ft. in total height or length unless an approved expansion and contraction joint is installed at intervals not to exceed 30 ft. In lieu of expansion joints, offsets of 2’-0” at 45° every 30 feet may also be used.

3.6 ROOF PIPE SUPPORTS

A. MIFAB (MIRO Industries, Copper B Line) #C-Port Series rubber support with 14 gauge galvanized, 13/16" high steel channel. Material shall be 100% recycled rubber that is UV resistant and can be used as a curb (sleeper) replacement. Designed to support gas and domestic plumbing system.

END OF SECTION 22 05 29

SECTION 22 07 00
INSULATION

Part 1. – GENERAL

1.1 SUMMARY

A. Field applied insulation for thermal efficiency and condensation control for plumbing piping and equipment.

B. Definitions:

1. ASJ: All service jacket, white finish facing or jacket.
2. Air Conditioned Space: Space directly supplied with heated or cooled air.
3. Cold: Equipment or piping handling media at design temperature of 60° F or below.
4. Concealed: Piping above ceilings and in chases and pipe spaces.
5. Exposed: Piping and equipment exposed to view in finished areas or exposed to outdoor weather.
6. FSK: Foil-scrim-kraft facing.
7. Hot: Plumbing equipment or piping handling media above 105° F.
8. Density: Pcf - pounds per cubic foot.
9. Thermal conductance: Heat flow rate through materials.
10. Flat surface: BTU per hour per square foot.
11. Pipe or Cylinder: BTU per hour per linear foot.
12. Thermal Conductivity (k): BTU per inch thickness, per hour, per square foot, per degree F temperature difference.
13. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

Part 2. - PRODUCTS

2.1 SUMMARY

A. Materials:

1. All insulation shall have composite (insulation, jacket, and/or facing and adhesive used to adhere the facing or jacket to the insulation), fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 225 and U/LI 723 not exceeding Flame Spread 25 and Smoke Developed 50.
2. Jacket and Facing Descriptions:

    a. All purpose vapor barrier jackets.
    b. VB vapor barrier, white kraft bonded to 1 mil aluminum foil, reinforced with glass yarn. Water vapor permeability 0.02 perms.
    c. FSK reinforced foil and paper (Foil Scrim Kraft). Aluminum foil (minimum 0.75 mil thick) reinforced with fiberglass yard mesh and laminated to 40 lbs. chemically treated fire resistant Kraft UL rated.

3. Exterior Jacket:

    a. Venture Tape, Ventureclad 1557CW, (Alumaguard 60) 6 mil thickness, adhesive backed, aluminum finish jacket otherwise with zero permeability, shall be capable of being applied down to -20° F.

2.2 PIPING

A. Piping shall be insulated with Manville (IMCOA, Owens-Corning, Knauf) "FLAME SAFE" fiber glass insulation. The insulation shall have an average thermal conductivity not exceeding 0.22 BTU in. per sq. ft. per °F. hour at mean temperature of 75°F.

B. Provide galvanized steel shields at all pipe hangers on insulated piping except hot water heating piping where pipes bear directly on the clevis. Shields shall be 16 gauge for pipes 4" and larger diameter and 20 gauge for smaller pipes.

C. Exposed areas inside a building shall be furnished with factory applied "FLAME SAFE" All-Purpose Vapor barrier jacket.

D. All piping in concealed areas inside a building shall be provided with factory applied "FLAME SAFE" VB (Vapor Barrier Jacket or All-Purpose Jacket).

E. All piping that is located outside and directly or indirectly exposed to the weather and is insulated, shall be totally enclosed and wrapped with a PVC pre-formed jacket.

F. Fittings, valve bodies and flanges for pipe size 4" and smaller shall be provided with PVC jackets over fiberglass inserts.

G. Armstrong (Rubatex, Halstead) Armaflex II flame retardant elastomeric thermal insulation, installed according to manufacturer's recommendations and as allowed by Local Codes, shall be suitable for pipe temperatures between -40° and 220°.

Part 3. - EXECUTION

3.1 GENERAL

A All piping shall be thoroughly cleaned and dry prior to the application of insulation.

B. Furnish and install continuous and uncompromised insulation and jacket independent of sleeves, penetrations, supports and anywhere adjacent trade's work occurs.

C. Provide continuous vapor barrier over all seams.

3.2 PIPING:

A. On cold water piping all seam edges shall be additionally sealed with vapor barrier adhesive and ends wrapped with vapor barrier tape overlapped the adjacent jacket.

B. All domestic water piping within 15' of any exterior opening within the mechanical room shall be insulated with a minimum of 1" Fiberglass unless indicated otherwise in this specification section.

C. For piping exposed to outdoor air, see insulation thicknesses for specific piping types below. Increase insulation thickness listed by ½".

D. Sealed combustion appliance exhaust vent piping shall be insulated in attic or cold spaces with 2" thick or R8 equivalent insulation or per manufacturers minimum recommended thickness, whichever is greater.

E. All existing insulated piping that may have had its insulation removed as a result of new work shall be reinsulated to match existing.

F. Vertical or horizontal primary and overflow storm water piping shall be insulated with 1" fiberglass, Armaflex or foam flat stock for the first 4 feet from the roof drains. The underside of roof drain bodies shall be insulated with 1½" fiberglass cemented to the drain and finished with a vapor barrier and adhesive to provide for complete vapor tight enclosure for the insulation.

G. Primary stormwater piping in or on the outside or inside of exterior wall going into or on to the ground shall be heat traced and insulated. Electrical heat tracing shall be covered by 1½" fiberglass insulation or the amount of insulation recommended by the heat trace manufacturer, whichever is greater. All exposed piping insulation shall be totally enclosed and wrapped with PVC pre-formed jacket.

H. Primary stormwater roof drains and piping in an unheated parking or plaza area shall be heat traced and insulated for the entire length until it goes underground. Electrical heat tracing shall be covered by 1 ½" fiberglass insulation or the amount of insulation recommended by the heat trace manufacturer, whichever is greater. The insulation shall be totally enclosed and wrapped with PVC pre-formed jacket. Piping underground shall utilize heat tape inside the piping until the piping has 4 feet of ground cover.

I. DOMESTIC COLD AND HOT WATER PIPNG:

1. Domestic cold and hot water shall have fiberglass insulation in thickness as follows or per applicable State Energy Code, whichever is greater.

2. (0ºF - 140ºF):

a.	1/2" thru 1 1/4 "	1"
b.	1 1/2" and larger	1 1/2"

3. (141ºF - 200º F):

a.	1/2" thru 1 1/4"	1 1/2"
b.	1 1/ 2 " and larger	2"

4. ½" runouts routed in PEX tubing to the fixture do not require insulation.

J. DOMESTIC RECIRCULATING HOT WATER:

1. (0ºF - 140ºF):

a.	1/2" thru 1 1/4 "	1"
b.	1 1/2" and larger	1 1/2"

3.3 JACKETS

A. Foil and Paper Jackets: Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1 1/2" laps at longitudinal joints and 3-inch-wide butt strips at end joints.

1. Seal openings, punctures and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.
2. Install PVC fitting covers over insulated flanges, fittings and valves.

B. Exterior Exposed Insulation: Install continuous PVC jackets and seal all joints and seams with waterproof sealant.

C. Install the PVC jacket with 1" overlap at longitudinal and butt joints and seal with adhesive.

END OF SECTION 22 07 00

SECTION 22 10 00
PIPING MATERIALS AND METHODS

Part 1. - GENERAL

1.1 SUMMARY

A. All piping materials and methods of construction and workmanship shall be provided as per the requirements of local codes and regulations.

1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
2. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

B. Lead pipe, solders, flux, etc., are not allowed. All piping and valves associated with the potable water system shall not exceed the 0.25% maximum lead content per U.S senate Bill No. S.3874 and NSF/ANSI 372.

C. The contractor is responsible for verifying all invert elevations with respect to building finished floor elevations and site provisions.

Part 2. - PRODUCTS

2.1 PIPING

A. Below Grade Sanitary, Vent and Waste:

1. Bell and spigot (SV) cast iron piping and fittings conforming to ASTM A74 (latest edition), manufactured by either AB & I Foundry, Charlotte Pipe, New Age Casting or Tyler Pipe, bearing the raised trademark on the piping of the Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations.
2. Hubless cast iron pipe and fittings conforming to CISPI 301 and ASTM A888, (latest revision), manufactured by AB & I Foundry, Charlotte Pipe, or Tyler Pipe, New Age Casting, bearing the raised trademark on the piping of the Cast Iron Soil Pipe Institute and be listed by N.S. F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the above mentioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations. Contractor shall submit to engineer, pipe manufacturers the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Standard stainless steel couplings, manufactured by Husky, Anaco or Ideal conforming to ASTM C1277, latest revision, or with heavy duty stainless steel couplings (Husky/Anaco/Ideal) third party certifying to ASTM C1540, latest revision. All cast iron pipe, fittings & couplings must be installed, supported & restrained using the installation procedures detailed in the CISPI handbook.
3. PVC Schedule 40, ASTM D2665-04a with mechanical ring, or fusion or solvent cement. Piping shall be laid on a continuous granular bed and installed per ASTM D2321.

B. Below Grade Rainwater Piping:

1. Bell and spigot (SV) cast iron piping and fittings conforming to ASTM A74 (latest edition), bearing trademark of Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations with neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations.
2. Hubless cast iron pipe and fittings conforming to CISPI 301 Standards and ASTM A888, (latest revision) bearing trademark of Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations with standard stainless steel couplings, conforming to ASTM C1277, latest revision, or with heavy duty stainless steel couplings conforming to ASTM C1540, latest revision. All cast iron pipe, fittings & couplings must be installed, supported & restrained using the installation procedures detailed in ASTM C1277 or ASTM C1540, whichever applies.
3. PVC Schedule 40, ASTM D2665 with mechanical ring or fusion or solvent cement. Piping shall be laid on a continuous granular bed and installed per ASTM D2321.
4. ABS Schedule 40. Pipe and corresponding fittings must be laid on a continuous granular bed and installed per ASTM D2321.
5. Reinforced concrete pipe. ASTM C76 Class III or greater, depending on trench loading calculations with rubber gasket joints.

C. Above Grade Sanitary, Vent and Waste:

1. Bell and spigot (SV) cast iron piping and fittings conforming to ASTM A74, (latest revision) bearing trademark of Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations with neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per the manufacturers recommendations.
2. Hubless cast iron pipe and fittings conforming to CISPI 301 Standards and ASTM A888, (latest revision), bearing trademark of Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations with standard stainless steel couplings (Husky/Anaco), conforming to ASTM C1277, latest revision, or with heavy duty stainless steel couplings (Husky/Anaco), conforming to ASTM C1540, latest revision. All cast iron pipe, fittings & couplings must be installed, supported & restrained using the installation procedures detailed in ASTM C1277 or ASTM C1540, whichever applies.

3. PVC Schedule 40, ASTM D2665-04c with mechanical ring, or fusion or solvent cement.
4. ABS Schedule 40, ASTM D2661-02. Pipe and corresponding fitting installed per code limitations.
5. PVC Schedule 80 threaded, ASTM D2665. Pipe and corresponding fittings, installed per code limitations.
6. Plastic piping shall not be used in air plenum spaces.
7. Pressurized waste discharge (i.e. sump pumps, sewage ejectors, etc.) shall be schedule 40 galvanized steel.

D. Above Grade Rainwater Piping:

1. Acceptable Manufacturers: Victaulic, Grinnell, Anvil-Gruvlok.
2. PVC Schedule 40 unthreaded or PVC Schedule 80 threaded. Pipe and corresponding fittings installed per code limitations.

    a. Victaulic flexible type couplings Style 75 and 77, Anvil-Gruvlok 7001 and 7000 and Grinnell Style 705 and 707 may be used on grooved end PVC pipe.

3. Victaulic flexible type couplings Style 75 and 77, Anvil-Gruvlok 7001 and 7000 and Grinnell Style 705 and 707 may be used on grooved end PVC pipe.
4. ABS Schedule 40. Pipe and corresponding fittings installed per code limitations.
5. Bell and spigot (SV) cast iron piping and fittings conforming to ASTM A74, (latest revision), bearing trademark of Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations with neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per the manufacturers recommendations.
6. Hubless cast iron pipe and fittings conforming to CISPI 301 Standards and ASTM A888, latest revision, bearing trademark of Cast Iron Soil Pipe Institute and be listed by N.S.F. International. For other Manufacturers, in addition to meeting the ASTM A74, they must also submit through the contractor the following records: (1) Radiation screening, (2) Chemical Testing Records for every 4 hours, (3) Mechanical Tensile testing for every 4 hours, (4) Dimensional Inspection records done every 12 hours and (5) Certification Letter from Manufacturer. The Contractor shall select 3 random dates for the aforementioned tests. Provide Neoprene compression joints conforming to ASTM C564, latest revision. Pipe, fittings & gaskets to be installed per manufacturers recommendations with standard stainless steel couplings (Husky/Anaco) conforming to ASTM C1277, latest revision, or with heavy duty stainless steel bands conforming to ASTM C1540, latest revision. All cast iron pipe, fittings & couplings must be installed, supported & restrained using the installation procedures detailed in ASTM C1277 or ASTM C1540, whichever applies.
7. Plastic piping shall not be used in air plenum spaces.

E. Below Grade Domestic Water:

1. Ductile iron pipe with mechanical joints conforming to AWWA C 151/ANSI 21.51 with joints conforming to AWWA C 111 installed in accordance with AWWA C 600 and joint restraints to be MJ FIELD-LOK as manufactured by U.S. Pipe, Clow, McWane/Tyler Pipe or Gruvlok.
2. Provide anchor rods for bends tees and plugs use thrust blocks for all 45 degree or greater elbows or joint restraint MJ FIELD-LOK as or U.S. Pipe, Clow or McWane/Tyler pipe.
3. Cast iron mechanical joint fittings AWWA C110 or ductile iron mechanical joint fittings AWWA C 153/ANSI 21.51 with joints conforming to AWWA C111 installed in accordance with AWWA C 600 and joint restraints to be MJ FIELD-LOK as manufactured by U.S. Pipe, Clow or McWane/Tyler Pipe (only upstream of water meter).

4. Water service piping up stream of the meter and the fire sprinkler riser assembly shall utilize protective internal coatings meeting AWWA standards. No unlined pipe allowed.
5. For inside building, 2 ½" and smaller under slab on grade, tube Type 'K' or 'L', ASTM B-88 soft copper, seamless and no fittings. For water services outside the building, 3" and larger type K copper.
6. Chlorinated Polyvinyl Chloride (CPVC): Manufactured from Type IV Grade I CPVC compound with a cell classification of 23447 per ASTM D 2846.
7. Cross Linked Polyethylene (PEX): Manufactured in the PEX-A Engel Method by Uponer, Watts Water PEX, Nibco, Viega PEX Ultra, Zurn, Roth. Not allowed for water service outside the building.

    a. Contractor to formally submit product/installation package to local jurisdiction prior to bid, based on Minnesota Plumbing Code Section 4715.0330.
    b. Piping shall meet or exceed ASTM F876-04 and ASTM F877-02a and be certified by NSF International for use with potable water.
    c. Fittings shall be PEX-A cold expansion type manufactured to meet or exceed ASTM F1960-04 and by certified by NSF International for use with potable water. Provide color coded rings.
    d. No fittings allowed below floor slab on grade.
    e. Manifolds shall be provided with appropriate sized fittings on manifold supply outlets.
    f. Provide angle stops, straight stops, bend supports, clips and/or pex rails as supplied by tubing manufacturer for supporting tubing.
    g. Installation shall be by a factory trained installer per manufacturer's installation instruction. Provide Owner with 25 year manufacture's warranty.
    h. Piping system will comply with ANSI/NSF Standard #61 for potable water.
    i. Pex piping shall not be in contact with any other uninsulated piping.

F. Above Grade Domestic Water Piping:

1. Acceptable Manufacturers: Victaulic, Grinnell, Anvil-Gruvlok.
2. Type "L" seamless hard temper copper tubing with wrought copper fittings, using 95/5 solder or brazing.
3. Type "L" seamless grooved copper tube with copper-tube dimensioned grooved copper couplings and fittings.

    a. Fittings shall be ASME B16.22 wrought copper or ASME B16.18 cast bronze, with copper-tube dimensioned grooved ends. Victaulic Grinnell Copper-Connection conforming to NSF/ANSI 372, or Anvil-Gruvlok CTS.
    b. Couplings shall be installation-ready. Grade EHP, EPAM or EHT gasket rated to + 250° F, and zinc electroplated steel bolts and nuts.
    c. System shall be manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)

4. Grinnell Copper G-Press and Viega Pro-Press system may be used on type L and M hard copper tubing, sizes ½" to 4" and soft copper tubing in ½" to 1 ¼". System shall be approved for up to 200 psi operating pressure and 250ºF for joining copper tubing. These systems shall only be used on piping system containing fluids and gases as indicated in the manufacturers approved listing. All application shall include the proper factory standard or field installed specialty seals.
5. Chlorinated Polyvinyl Chloride (CPVC): Manufactured from Type IV Grade I CPVC compound with a cell classification of per ASTM D1784 of 24448 for pipe materials and 23447 for fitting materials. CPVC pipe and fittings shall be certified by NSF International and International Code Council, Evaluation Service, Plumbing, Mechanical and Natural Gas for use with potable water.
    a. Pipe and fittings 2" and smaller:

        (1) Pipe and fittings shall be copper tube size (CTS) SDR 11 and shall meet or exceed ASTM D2846.
        (2) The maximum water design velocity shall be 8ft./sec.
        (3) Pipe and fittings: FlowGuard Gold, Charlotte Pipe.

b. Pipe and fittings larger than 2":

(1) Pipe shall be iron pipe size (IPS) Schedule 80 and shall meet or exceed the requirements of ASTM F441.
(2) Fittings shall be iron pipe size (IPS) Schedule 80 and shall meet or exceed the requirements of ASTM F437.
(3) The maximum water design velocity shall be 5 ft./sec.
(4) Pipe: Corzan, GFHarvel of IPEX.
(5) Fittings: Corzan, NIBCO or IPEX.

c. All socket type joints shall be made with solvent cements and primers shall meet or exceed current ASTM standards. Solvent cement and primer shall be listed by NSF International for use with potable water and approved for use with pipe and fittings manufacturer.
d. Provide smooth pipe supports and bracing to allow for expansion and contraction. Spaced per manufacturer's recommendations.
e. Installation shall be by a factory trained installer per manufacturer's installation instruction. Provide Owner with minimum of 5 year manufacturer's warranty.
f. Plastic piping shall not be used in air plenum spaces.
g. All valves, accessories, and appurtenances used with CPVC piping system shall have a metallic body with flanged or threaded connections.
h. All threaded connections shall be made using manufacturers male adapter fittings with metallic threads. Fittings with plastic threads are not acceptable.

6. Cross Linked Polyethylene (PEX): Manufactured in the PEX-A Engel Method by Uponor, PEX by Nibco, Viega PEX Ultra, ½" through 3", Zurn, Roth.

a. Contractor to provide and install PEX per Local Code.
b. Piping shall meet or exceed ASTM F876-04 and ASTM F877-02a and be certified by NSF International for use with potable water. Piping shall be rated at 100 psi at 180˚ F.
c. Fittings shall be PEX-A F1960 cold expansion type manufactured to meet or exceed current ASTM standards and by certified by NSF International for use with potable water. Provide color coded rings and or pipe.
d. Manifolds shall be provided with appropriate sized fittings on manifold supply outlets.
e. Provide angle stops, straight stops, bend supports, clips and/or pex rails as supplied by tubing manufacturer for supporting tubing. Support piping every 2'-8". Support piping can exceed 2' – 8" when using a listed support assembly such as PEX A pipe support
f. Individual piping shall maintain a 2" minimum spacing. Bundled hot and cold piping is not acceptable.
g. Installation shall be by a factory trained installer per manufacturer's installation instruction. Provide Owner with 25 year manufacture's warranty.
h. Shall not be used on systems exceeding 140ºF.
i. PEX piping or assembly shall be air plenum rated to meet ASTM E84.

G. Domestic Hot Water Circulation:

1. Acceptable Manufacturers: Victaulic, Grinnell, Anvil-Gruvlok.
2. Type "L" seamless hard temper copper tubing with wrought copper fittings, using 95/5 solder or brazing.
3. Type "L" seamless grooved copper tube with grooved copper fittings and couplings.

a. Fittings shall be ASME B16.22 wrought copper or ASME B16.18 cast bronze, with copper-tube dimensioned grooved ends. Grinnell Copper Grove System, Victaulic Copper-Connection and Anvil-GruvLok CTS.
b. Couplings shall be installation-ready, for direct stab installation without field disassembly. Couplings shall consist of two ductile iron housing segments cast with offsetting angle-pattern

bolt pads, Grade EHP or EPDM gasket rated to +250° F, and zinc electroplated steel bolts and nuts. Victaulic Style 607, Grinnell Style 640 and Anvil-GruvLok 6400/6402.

c. System shall be manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)

4. Grinnell Copper G-Press and Viega Pro-Press system may be used on type L and M hard copper tubing, sizes ½" to 4" and soft copper tubing in ½" to 1 ¼". System shall be approved for up to 200 psi operating pressure and 250ºF for joining copper tubing. These systems shall only be used on piping system containing fluids and gases as indicated in the manufacturers approved listing. All application shall include the proper factory standard or field installed specialty seals.
5. Chlorinated Polyvinyl Chloride (CPVC): Manufactured from Type IV Grade I CPVC compound with a cell classification of per ASTM D1784 of 24448 for pipe materials and 23447 for fitting materials. CPVC pipe and fittings shall be certified by NSF International for use with potable water.

   a. Pipe and fittings 2" and smaller:

      (1) Pipe and fittings shall be copper tube size (CTS) SDR 11 and shall meet or exceed ASTM D2846.
      (2) The maximum water design velocity shall be 8ft./sec.
      (3) Pipe and fittings: FlowGuard Gold, Charlotte Pipe.

   b. Pipe and fittings larger than 2":

      (1) Pipe shall be iron pipe size (IPS) Schedule 80 and shall meet or exceed the requirements of ASTM F441.
      (2) Fittings shall be iron pipe size (IPS) Schedule 80 and shall meet or exceed the requirements of ASTM F437.
      (3) The maximum water design velocity shall be 5 ft./sec.
      (4) Pipe: Corzan, GFHarvel of IPEX.
      (5) Fittings: Corzan, NIBCO or IPEX.

   c. All socket type joints shall be made with solvent cements and primers shall meet or exceed current ASTM standards. Solvent cement and primer shall be listed by NSF International for use with potable water and approved for use with pipe and fittings manufacturer.
   d. Provide smooth pipe supports and bracing to allow for expansion and contraction. Spaced per manufacturer's recommendations.
   e. Installation shall be by a factory trained installer per manufacturer's installation instruction. Provide Owner with minimum of 5 year manufacturer's warranty.
   f. All valves, accessories, and appurtenances used with CPVC piping system shall have a metallic body with flanged or threaded connections.
   g. All threaded connections shall be made using manufacturers male adapter fittings with metallic threads. Fittings with plastic threads are not acceptable.

6. Plastic piping shall not be used in air plenum spaces.
7. Cross Linked Polyethylene (PEX): Manufactured in the PEX-A Engel Method by Uponor, Watts Water PEX, Nibco, Viega PEX Ultra, ½" through 3", Zurn.

   a. Contractor to formally submit product/installation package to local jurisdiction prior to bid.
   b. Piping shall meet or exceed ASTM F876-04 and ASTM F877-02a and be certified by NSF International for use with potable water. Piping shall be rated at 100 psi at 180°F.
   c. Fittings shall be PEX-A cold expansion type manufactured to meet or exceed ASTM F 1960-04, ASTM 1807, ASTM 2098, ASTM 2080 and by certified by NSF International for use with potable water.

d. Provide angle stops, straight stops, bend supports, clip and/or pex rails as supplied by tubing manufacturing for supporting tubing. Support piping every 2'-8". Support pipping can exceed 2'-8" when using a listed support assembly such as a PEXA pipe support.
e. Installation shall be by a factory trained installer per manufacturer's installation instruction. Provide Owner with 25 year manufacture's warranty.
f. Shall not be used on systems exceeding 140ºF.
g. Individual piping shall maintain an 2" minimum spacing. Bundled hot and cold piping is not acceptable
h. PEX piping or assembly shall be air plenum rated to meet ASTM E84.

H. Rigid Natural Gas Piping:

1. Inside Building:

a. Schedule 40 black steel with threaded fittings, ASTM A 53/ASTM A 53M-04a.
b. Type L seamless soft copper, ASTM B 88-03 and copper fittings. Copper piping shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic of gas.

2. In Ceiling Air Plenum:

a. Schedule 40 black steel with standard butt weld fittings.
b. Type L seamless soft copper and copper fittings. Copper piping shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic of gas.
c. All welded or brazed connections in air plenum ceilings and concealed spaces. Use no valves, threads, unions or connectors in these locations. Concealed gas piping in solid partitions shall be inside a Schedule 40 black steel pipe sleeve capped at both ends and vented outside the building.

3. Inside Mechanical Room: Schedule 40 black steel with threaded fittings.
4. Exterior Underground (2 psig or less):
a. PE (polyethylene) plastic and shall be marked "gas" and "ASTM D 2513-04a" and shall be used with factory assembled steel riser.
b. Type L seamless soft copper, ASTM B 88-03 shall be used with factory assembled steel riser. Copper piping shall not be used if the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic of gas.

5. Exterior Aboveground:

a. Schedule 40 steel, black, welded and seamless with threaded fittings, ASTM A 53.
b. Schedule 40 steel, hot dipped zinc-coated (galvanized welded and seamless with threaded fittings, ASTM A 53.

I. Flexible Gas Piping Systems:

1. FlashShield metallically shielded corrugated stainless-steel tubing (CSST), complying with the ANSI LC-1/CSA standard "Fuel Gas Piping System Using Corrugated Stainless Steel Tubing. Material shall meet ASTM A240 and shall be type 304 stainless steel with a minimum wall thickness of 0.01". Tubing jacket to be multilayer, consisting of a metal mesh between two semi-conductive polymer layers being UV-Resistant and meeting ASTM E84 rating of 25 for flame spread and 50 for smoke. Mechanical tube fittings manufactured from ASTM B16 Type 360 brass. Brass fitting to include jacket-lock feature to provide a contact seal between the fitting assembly and outer polymer layer of the CSST. FlashShield supplied training shall be obtained by all installers prior to installation. The gas piping system shall be installed, and pressure tested in accordance with all requirements of local Code, ANSI LC-1 and the most current edition of the FlashShield Design and Installation Guide.

2.2 VALVES

A. Acceptable Valve Manufacturers:

1. Apollo, Titan FCI, Milwaukee, Victaulic, Nibco, Watts, Mueller, Hammond, Griswold, Anvil-Gruvlok, Grinnell, Anvil-International, Uponor.
2. All valves for potable water shall be low level lead 0.25 percent average lead content.

B. Gate Valves –Domestic Water Piping:

1. 2 inches and Smaller: Milwaukee Figure UP148 or Hammond Figure UPIB640, 125 pound bronze bodied valve with screwed end connections. The solid style disc and bonnet shall also be bronze, and the rising-type stem shall be copper-silicon alloy.
2. 2-1/2 inches and Larger: Milwaukee Figure 2885 or Hammond Figure IR 1140, 125 pound cast iron bodied valve with bronze fittings and flanged end connections. The solid style bronze disc shall be fully guided. The stem shall be steel with OS & Y construction.

C. Check Valves –Domestic Water Piping:

1. 2-1/2 inches and Smaller: Milwaukee Figure UP509, Hammond Figure UPIB904, 150 pound bronze, screwed ends, bronze disc, swing check.
2. 3 inches and Larger: Milwaukee Figure 29274-M13/Hammond IR1937, 150 pound check valve with 3 percent nickel cast iron body and disc, a stainless steel seat and pin and flanged connections.
3. 2 inches and Larger: Grooved end swing check valve, Victaulic Series 712, 300 psig CWP, with ductile iron body and cap, with stainless steel disc and shaft, for horizontal installation or Grinnell Style 590.
4. Non-Slam Check Valves - 3 inches and Larger: Mueller Steam Specialty 105 MAT, Titan FCI CJ50-DI-DBS, 125 pound globe style check valves with EPDM inserts.
5. Non-Slam Check Valves - 2-1/2 through 12 inches: Victaulic Series 716, 300 psig spring-actuated check valve, with stainless steel spring and shaft, for horizontal or vertical installation.

    a. For sizes 14 through 24 inches, valves shall be Victaulic Series W715, rated to 230 psig, with stainless steel spring, shaft, and dual disc(s), and EPDM seat or Anvil-Gruvlok 7800.

D. Ball Valves –Domestic Water Piping:

1. 3” and smaller for domestic water: Milwaukee UPBA475/485 two piece full port forged brass body 600 WOG chrome plated ball, blow out proof stem, reinforced PTFE seats and where necessary, extended stems for insulation conforming to NSF 61 for potable water.
2. Grooved End Ball Valves: 1-1/2” and Larger, for domestic water service with steel piping systems, GRUVLOK Series 7500, Grinnell Fig BV835 or Victaulic Series 726 or Anvil-Gruvlok 7500 two-piece ductile iron body with chrome-plated steel or stainless steel standard port ball, blow out proof stem, PTFE seats, and lever handle or gear operator.
3. 4” and larger for domestic water: Milwaukee Series F20SS150R-02 flanged full port 150 lb. stainless steel ball valve with stainless steel ball and stem, reinforced PTFE seats and blow out proof stem. Provide extended stems for insulation or balancing stops for modulating services.

2.3 FLOW FITTINGS/BALANCE VALVE

A. Acceptable Manufactures:

1. Bell & Gossett, Nibco, Mueller, Victaulic/TA Hydronics, Anvil-Gruvlok, Grinnell, Thermomegatech, Calefi.

A. Calefi model 127 pressure independent balancing valve. Dezincification resistant low lead brass body, interchangeable flow cartridge, with union ends. Provide valves with flow rates as indicated on drawing. Valve shall be provided with upstream and downstream shut off valves to facilitate valve replacement or repair.

B. CircuitSolver Thermostatic: Balancing valve, self actuating balancing valve, line sized at 120°F closing temperature unless noted otherwise. Valve shall be NSF/ANSI 61 certified. Provide Model CSUA with integral union, check valve and isolation ball valves.

C. Bell & Gossett Tempsetter or Calefi Thermosetter. Valve shall be adjustable with a minimum range of operation between 98°F to 140°F. Valve body shall be 316 stainless steel, dezincification brass or bronze. All parts of the valve exposed to domestic water shall be stainless steel, copper or copper alloy. Valve shall be NSF/ANSI 61 certified. Valve shall be installed with shut-off valves upstream and downstream of valve, and check valve on the downstream side.

2.4 MIXING VALVES

D. Acceptable Manufacturers:

1. Symmons, Watts, Leonard, Powers, Lawler, Apollo.

E. MV-1 High/Low Mixing Valve Station: Lead free digital water temperature control and monitoring system shall feature 3.5" full-color touchscreen interface which is configurable on location and does not require factory pre-programming. System shall control water temperature to +/- 2°F in accordance with ASSE 1017 and resist "temperature creep" during periods of low/zero demand. Controller shall be password protected and feature a user-adjustable outlet temperature range of 60 – 180°F with high and low temperature alerts, and an approach temperature of 2°F. System shall digitally control and monitor mixed outlet temperature. Controller shall integrate with building automation systems (separate module not required) through BACnet and Modbus protocols. Controller shall be equipped with secure Wi-Fi protocols WPA2-PSK and WPA2-PEAP-MSCHAPv2. System will feature a user-set, high-temperature sanitization mode for thermal disinfection of bacteria and a programmable temperature set back feature to improve energy efficiency. System will also feature high speed actuator with override feature. In the event of a power failure, system will open full cold supply. In case of a loss of cold water, the system will close hot water supply. System shall be listed/approved to ASSE 1017, cUPC, NSF, CSA 60730 and BTL (BACnet Testing Laboratories)

F. Point of use Mixing Valve: Public Lavs. Powers-Watts HydroGuard Lead Free Series LFe480 or LFG480 tempering valve. Adjustable temperature selection with locknut. Temperature controls to ASSE 1070, down to 0.5 gpm for the LFe480 and 0.25 gpm for the LFG480. Intergral check with screen to prevent cross flow and filter out debris. Provide painted recessed cabinets if there is no cabinet under the sink. Verify color of cabinet with Architect.

2.5 BACKFLOW PREVENTERS

A. Acceptable backflow preventer Manufacturers:

1. Watts, Conbraco, Febco, Ames, Lawler, Hersey, Wilkins, Apollo.

B. Contractor shall verify the availability of testing agency for reduced pressure zone backflow preventers in project area.

C. Swimming Pool, Irrigation - Watts #009-QT-Reduced Pressure Zone assemblies, high hazard, continuous pressure and quarter turn ball valves.

D. Trash Chute Wash-Down – Watts #LF-188A, Atmospheric, lead free, anti-siphon vacuum breaker, high hazard, non-continuous pressure.

E. Commercial Type Dishwasher, Shampoo Sink- Watts #LF-188A, Atmospheric Vacuum Breaker, lead free, high hazard, non continuous pressure.

F. Ice Machine, Carbonator for Beverage Dispensers and Coffee Machines - Watts #SD-3 stainless steel, dual check valve, continuous pressure, lead free, low hazard, with intermediate atmospheric vent.

2.6 WATER PRESSURE REDUCING VALVES

A. Acceptable Manufacturers:

1. Watts, Conbraco, Armstrong, Febco, Wilkins, Apollo.

B. Valves 1/2 inch to 2 inch: Watts, Model LFU5B, lead free, including nipple and bronze strainer. PSI regulating range: 25-75. Maximum working pressure of 250 psig. ASSE Standard No.1003.

C. Valves 2 1/2 inch and larger: Watts Model LFN223B, lead free, high capacity with strainer and flanged ends. PSI regulating range: 25 – 27. Maximum working pressure of 250 psig. ASSEE Standard No. 1003.

D. Furnish and install a pressure reducing valve ahead of the dishwasher if required and set to provide 20 psi at the inlet. On dishwasher with built-in water heater consult with kitchen equipment supplier and provide watts U5LP 1" reducing valve with built-in thermal expansion bypass and pressure gauge on the booster water heater inlet piping. Set the reducing valve to provide 15 psig water during full flow conditions.

2.7 GAS VALVES

A. Acceptable Manufacturers:

1. Apollo, Siemens, Asco, Backmann, Milwaukee, Hammond, Velan, Homestead.

B. 2" and Smaller: Milwaukee BA 475 threaded forged brass two piece ball valve with chrome plated ball, blowout, blowout proof stem and reinforced PTFE seats in accordance with UL-MHKZ (600#) CSA 3371-08/CSA3371-88 (1/2#), CSA 3371-92/CSA 3371-12 (5#), CSA 3371-94 (125#). Provide stem extensions where required.

C. Provide a natural gas pressure regulator shall be Maxitrol to reduce gas pressure to an acceptable limit at gas fired equipment. See plans for gas company meter outlet pressure. See mechanical equipment schedule for required capacities and operational manuals for pressure limits. Provide with code approved pressure limiting device or pipe pressure regulating valve relief vent individually to the outside. Verify with the local code authorities.

D. Gas Solenoid Valves: Asco #K3A4 Series, approved UL rated automatic gas shutoff valves. Normally closed, 24 volt D.C. with manual reset, sized to match gas piping service to equipment.

2.8 MISCELLANEOUS VALVES:

A. Drain Valves- Domestic Water Piping:

1. Nibco #C56-VB, ¾" male thread, tee handle and vacuum breaker.
2. Apollo Series 78-100 ball valve, 600 pound, bronze body, chrome plated brass ball and blow-out proff brass stem, reinforced Teflon seals and seats and ¾" hose thread outlet with cap or Milwaukee BAIOOH.
3. Milwaukee UPBA480BH, HoseXPress 200 lb. with blow off proof stem.

4. Domestic water drains shall be equipped with vacuum breakers.

Part 3. - EXECUTION

3.1 GENERAL

A. Provide offsets and transitions to plumbing piping due to existing structure and trades work.

B. Slope water piping 1" per 40' and arrange to drain at all low points.

C. All storm piping sloped 1/8” per foot and all sanitary piping sloped at 1/4/ft, 4” and larger may be sloped at 1/8” per foot where approved by AHJ, unless noted otherwise or if required to meet inverts. Notify engineer of any changes. All horizontal vent piping shall be sloped to allow internal moisture drain-off.

D. All underground sewer pipe within 10 feet of buried water supply piping shall be constructed in accordance with State and/or Local Code.

E. Provide all appropriate sanitary piping fittings, wyes and bends. No double-wye fittings for sanitary drainage in horizontal position shall be used. Fittings used for back to back toilets shall meet all toilet manufacturers installation instructions. Double sanitary tee shall not be used in back to back installations.

F. Vent pipes passing through roofs shall terminate at least 12" above the roof line.

G. Above grade plastic drain and vent piping horizontal runs cannot exceed 30 feet, without allowance for expansion. Solvent welds shall be done with a contrasting primer to the color of the pipe and cement. Plastic piping shall not be installed in air plenum spaces including parking garage area.

H. Provide shut-off valves by Code and good installation practice for the proper isolation of equipment. All branch take offs shall have isolation shut off valves. Provide extended stem valves where required for insulation. Except as otherwise specified or shown on plans, valves 2-1/2 inch and smaller shall have screwed end connections and valves 3 inch and larger shall have grooved end or flange end construction. Install manual drain valves at every low point of each water piping system.

I. All threaded nozzle fixtures to have atmospheric vacuum breakers.

J. Grooved joints shall be installed in accordance with the manufacturer’s latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor’s representative is not considered qualified to conduct the training or jobsite visit(s).

K. Installation of cross connection control devices and related valves shall maintain 1'-6" clear from wall or other obstructions, no more than 5'-0" above floor or closer than 2'-0" from floor.

L. Provide escutcheon plates at all wall, floor, or ceiling piping penetrations. This includes all mechanical piping systems. Escutcheon plates shall match the finish of the surrounding area.

M. Exposed PVC venting through roof shall be painted at the discretion of the Architect.

N. Provide a dielectric coupling or waterway fitting at all connections of dissimilar metals. Provide adequate clearance for insulation and for access to valves. All piping shall be concealed and shall maintain proper clearances for ceilings, ducts, walls, lighting, etc. except that piping may be exposed in mechanical areas. At

all fixture and equipment connections where nipples are necessary between copper fixtures and tubing, such nipples shall be full size brass nipples with brass or copper adapters.

O. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.

P. Provide shut-off valve for all gas fired equipment. Locate valve in an easily accessible location.

Q. Gas Piping on Roof:

1. Piping on roof shall be supported on polyethylene, high U.V. resistant Quick "Pipe" Blocks manufactured by Nelson-Olsen Inc. (Erico, E-Z Sleeper Block). Piping and blocking shall be installed to allow for expansion and contraction.
2. Exposed steel gas piping shall be properly cleaned and shall be painted with one coat of red primer and two (2) coats of oil paint "Silver Gray" color. This painting is not necessary on galvanized surfaces.

R. Push-to-Connect Joints: Install Permalynx joints in accordance with the manufacturer's latest published installation instructions. Prepare and mark tubing ends using a tool supplied by the manufacturer and in accordance with the manufacturer's instructions.

S. Install Vic-Press 304™ in accordance with Victaulic recommendations. Pipe shall be certified for use with the Vic-Press 304™ system, square cut (+/-0.030"), properly deburred, and cleaned. Pipe ends shall be marked with a gauge supplied by Victaulic. Use a Victaulic 'PFT' series tool with the proper sized jaw for pressing.

T. Provide 1/2" ethafoam on all above grade vertical piping for slab movement at wood floor penetrations.

U. Contractor shall comply with the CISPI Guide Lines Manual when installing piping.

V. Provide cleanouts where all sanitary and storm piping are connected to existing piping to facilitate testing.

W. In the event plastic and/or PEX piping is approved and installed, contractor shall maintain a minimum of 2 inch spacing hot and cold water and individual floor penetrations shall be provided. Bundling of hot and cold piping is not acceptable.

X. PEX piping shall not be installed within the first 1'-6' of piping connected to a water heater.

END OF SECTION 22 10 00

SECTION 22 30 00
PLUMBING SPECIALTIES

Part 1. - GENERAL

1.1 SUMMARY

A. Contractor shall provide all labor and materials to provide a complete plumbing and fuel system for all fixtures and equipment shown on drawings. Contractor shall rough-in and make final connections to all fixtures and appliances supplied by others.

B. Contractor shall thoroughly review the manufacturer's installation instructions prior to installing any piece of equipment or its associated service, (domestic drains, water piping, etc.). Any conflicts between the manufacturer's installation instructions and the plans or specification shall be brought to the engineer at once for clarification. Contractor will not receive additional money for installations requiring modifications due to these conflicts.

C. All plumbing systems shall meet State and Local codes as well as ADA requirements.

D. Gas Service: Make arrangements with the local gas company and pay all costs and fees for firm gas service including gas meter with shut off valve on each side of the meter. Verify exact location of gas meter and provide a gas shut off valve at the first accessible point within the building. Provide a gas pressure regulator and shut off valve in an easily accessible location at each appliance or unit of equipment and identify valve. Vent gas pressure regulators per code. Coordinate with all gas firing equipment including equipment supplied by others for gas pressure compatibility with the gas company. Contractor to provide Gas Company with a list of gas fired equipment and requirements. Coordinate gas pipe locations with all other trades.

E. Water Service:

1. Provide a separate domestic and fire sprinkler service from a point 5'-0" outside of the building as shown on the drawings. Minimum earth cover to be 8'- 0". Coordinate exact location of new services with other utility services and civil engineer. Refer to civil engineer's plan for continuation of services on site and refer to building Engineer's plan for service into the building. Provide backflow prevention that complies with AWWA-M14, Section 6.3 if required by local authorities. Contractor shall excavate, install, backfill, compact and patch to match existing conditions.
2. Provide domestic water meter, as supplied by the city, purchased by the contractor. Installation shall conform to City requirements.
3. Coordinate with the Civil Engineer, City Water Department, City Fire Marshal and the Fire Sprinkler Contractor.
4. Coordinate with the General Contractor. Verify and provide any special irrigation system requirements.

F. Sanitary and Storm Service:

1. Provide sanitary sewer service from a point 5'-0" outside of building where shown on the plans. Minimum earth cover to be 5' - 0". Contractor shall excavate, install, backfill, compact and patch to match existing conditions. Contractor shall coordinate with the city and civil engineer.

Part 2. - PRODUCTS

2.1 EQUIPMENT

A. Miscellaneous Plumbing Equipment:

1. Cleanouts:

a. Floor cleanouts in finished areas shall be Josam (Sioux Chief, MIFAB, Wade, Smith, Watts, Ancon, Zurn) Series 56000, with Nikaloy top. Provide carpet marker for carpeted floors. In unfinished areas, use Series 56000 floor cleanout with cast iron top. Install cleanouts at the bottom of all stacks, as indicated on drawings and by code.
b. All floor set fixtures further than 5 feet on a horizontal branch with separate concealed traps, such as a floor drain or trench drain receiving fouling waste shall have an integral cleanout or a cleanout as close as possible to the fixture
c. Bottom of stacks in unfinished areas shall be provided with a cleanout that has a plug with a seating flange, lead gasket and four square lugs for plug removal.
d. Access cover for wall cleanouts in finished rooms shall be Josam Series 58600 stainless steel round cover with screw.
e. Floor cleanouts in residences shall be 56010.
f. Clean-out plug or cover plates in walls shall not face public corridors or public areas.

2. Roof Jacks:
   a. Terminate all vents stacks 12" above roof in a frost-proof galvanized roof jack. Use lead top on cast iron and vinyl top on PVC vent pipe.
   b. All vents thru roof shall be 3" unless otherwise noted.
3. Floor Drains:
   a. Approved Manufacturers: Josam, Wade, Watts-Ancon, J.R. Smith, Zurn, Sioux Chief, MIFAB.
   b. Josam Series #30000-A complete with flashing and clamp and with adjustable nickel-bronze strainers.
   c. Floor drain in commercial kitchens shall be Josam #30000-6AD, with membrane clamp and strainer with clamping collar at finish floor.
   d. Floor drains in the mechanical rooms and trench drains shall be Josam #32100 cast iron.
   e. Floor drains shall be provided with a separate deep seal P-trap.
4. Floor Sinks (Food Service):
   a. Approved Manufacturers: Josam, Wade, Zurn, Ancon, Watts-Blucher.
   b. Josam Series 49000; Square Nikaloy sanitary sloped rim and Nikaloy anti-tilting super-flo grate, double drainage flange, acid-resisting interior, less dome strainer but with removable stainless steel mesh bucket liner. Provide with one-half style grate and separate deep seal P-trap.
5. Roof Drains:
   a. Approved Manufactures: Josam, Wade J.R Smith, Zurn, MIFAB, Watts-(Proset, concrete only).
   b. Roof Drains (RD) Josam #21500 “Levelese” series coated cast iron, polypropylene locking dome, clamp ring, integral gravel stop and adjustable top. Provide deck clamp for roof drains install in all roof construction, except poured concrete.
   c. Overflow roof drains shall be Josam Series 21500-16 of similar construction to standard roof drain except shall include a 3 inch high internal water guard.
   d. Setting of each roof drain shall include (1) 36” x 36” noblefex membrane flashing securely anchored into the drain.
   e. Verify roof construction with General Contractor.
   f. Where rainwater leader terminates through an exterior wall above grade, provide a downspout nozzle, Josam Series 25010 satin bronze finish.
6. Shock Arrestors:
   a. Approved Manufacturers: Josam, Zurn, Sioux Chief, Watts Drainage, MIFAB.
   b. Josam Absorbatron II 75000-S with wrought copper shell. Provide where required by Code, on flush valve systems and on the piping to any laundry unit or dishwasher. Size accordingly.

B. Sewage Ejector Pumps (Duplex) (SEP) – Submersible Type: Weil (Zoller, Peerless, Hydromatic, Goulds, Armstrong, Little Giant, Grundfos), as scheduled.

1. Furnish and install duplex submersible screenless sewage ejector of size and capacity as shown on the drawing and schedule.
2. Unit shall be suitable for passing 2” solids.
3. Motors shall be 4 pole 1750 rpm housed in air filled water tight cast iron motor shell with winding having Class “F” insulation and prelubricated double seal bearings. Motor shall meet NEMA 6 standards with neoprene power cable of required length. Motor shaft shall be stainless steel.

4. Provide duplex controller complete with starters and disconnects and lead/lag control capable of automatically starting lag pump if lead pump fails. Controller shall be factory wired to motors with single point power connection.
5. Impeller shall be two-vane type constructed of bronze and statically and dynamically balanced.
6. The pump manufacturer shall warrant pumps for a period of one year under normal use, operation and service.
7. Duplex: Furnish four float switches for duplex operation. Furnish a Nema 1/UL labeled control panel with main disconnect, with thru-the-door interlock, two manual disconnects with thermal overload, two magnetic contactors, electric alternator, selector switches, pilot lights, control transformers, high water alarm bell with silencing switch. Alternator to distribute operation to both pumps on each successive cycle and operate both units when one unit cannot handle the load.

C. Ejector Basin (EB): Basin and cover shall be Weil series 8811. Cast iron shall be ¼" thick steel, welded construction and covered inside and outside with two coats of bituminous Mastic #50. Minimum basin diameter shall be 3'-0" for simplex. Hub inlet and outlet connections shall be sized and located to fit pipe served. Provide suitable gas tight cast iron or steel cover to accommodate pump, piping and controls including inspection manhole. Covers for submersible pumps shall include hinged access door to facilitate pump removal. Cover to be flush with floor as to permit smooth foot traffic. Verify length prior to ordering.

D. Sump Basin (SPX): Basin and cover shall be fiberglass Weil (Topp, Gould, Zoeller). Install flush with finished floor and provide durable cover capable of supporting foot traffic. Verify depth required.

E. Sump Pumps (SPXX): Weil (Enpo, Hydromatic, Gould, Swaby, Zoeller, ABS) as scheduled. Pump shall be submersible with permanently lubricated bearings, stainless steel shaft, cast iron housing and galvanized strainer.

1. Simplex: Provide a U.L. rated control panel with float switch and high water alarm.

F. Water Heater (WH) Sealed Combustion, Combination Burner and Storage Tank Type: Provide a (A.O. Smith, Lochinvar, Rheem, State, Richmond, Mor-Flo, Bradford-White, P.V.I., Bock, Reco) sealed combustion water heater, with capacities indicated in the mechanical equipment schedule. 95% thermal efficiency. Unit shall be AGA certified and have intermittent electronic ignition, glass lined tank, dip tube, powered anode rods, modulating combustion system. ASME T & P relief valve piped to the floor, 150 psig working pressure, 3 year tank warranty, ASHRAE 90.1 and NAECA III energy compliant.

G. Exhaust vents for condensing water heaters or domestic water heating boilers shall be resistant to deleterious effects of corrosive materials, such as chloride ion pitting, crevice corrosion and stress corrosion, cracking and general corrosion in oxidizing environments. Material shall be made of superferritic stainless steel, type AL29-4C. In lieu of stainless steel, Poly Propylene (PP) or Chlorinated Poly Vinyl Chloride (CPVC may be acceptable, but are subject to manufacturers instruction. Poly Vinyl Chloride (PVC) is not acceptable. Concentric venting is not acceptable.

H. Thermal Expansion Domestic Water Absorber: Provide an Amtrol ST Therm-X-Trol ST-12V (Rheem, ITT & PT) the domestic water heater. Tank shall have a NSF listed rigid polypropylene liner, heavy duty butyl diaphram and outer steel shell. Tank shall be precharged to 40 psig and be of adequate size. All internal wetted parts must comply with FDA regulations. An internal butyl diaphragm shall be used to isolate air charge from water.

I. Circulating Pump (CP): Grundfos: All bronze circulating pump or stainless-steel circulating pump (Taco, B & G Series, Armstrong, Thrush, Peerless, Paco, Mepco) Electronically Communicated Motor (ECM), internal domestic water temperature self-sensing pump as scheduled with lubricated bearings. Provide isolation valves, check valve, strainer and balancing valve with integral read-out port and memory stop. Balance system to between 3 and 6 feet per second velocity.

J. Aquastat: Provide a Honeywell, nonimmersion, 30 degree differential, strap on type aquastat to cycle the domestic hot water pump when return water temperatures drop below its setting. The aquastat shall be

installed and wired by the Mechanical Contractor. Aquastat shall be immersion type if non-metallic piping is installed for recirculation piping.

Part 3. - EXECUTION

3.1 GENERAL

A. Provide shut off valve on all branch piping take offs. Locate as close as possible to main in an accessible location. Provide unions threaded connections and shut-off valves on both sides of any of the following but not limited to: Mixing valves, pressure reducing/regulating valves, water softeners, water heaters, check valves, hose reels, circulation pumps, flow fittings, back flow preventers, humidifiers, laundry washers and boiler make-up.

B. Rough-in and make final connections for kitchen food service equipment furnished under another division of the specifications. Refer to schedule on drawings for specific requirements. Furnish cast brass "P" traps with cleanouts and water supplies with loose key stops for all equipment. All exposed water piping shall be chrome plated brass. Where vent piping must be run exposed, install it within stainless steel sleeves.

C. Provide temperature and pressure gauges, pressure regulators, strainers, shock arrestors for residential dishwasher and laundry washers and an above counter to air gap fittings to comply with Code for dishwashers.

D. Rough-in and make final connections for all equipment in addition to equipment specified in this section. Coordinate with supplier to obtain correct location and sizes prior to rough-in.

E. Avoid installing sanitary waste piping over any food preparation equipment and food storage area or provide protection from drips with a functional water-tight safe pan.

F. Contractor shall coordinate all floor joist headering required for piping installation. Headering shall be done at contractor’s expense.

G. Coordinate locations of all venting sidewall or through the roof with the Architect and General Contractor prior to installation.

H. Provide condensate neutralization kit for condensate producing water heaters.

3.2 FIELD QUALITY CONTROL

A. Contractor shall engage a factory authorized representative service to supervise the field assembly of components and installation of domestic water heaters, including pumps, piping and electrical connections. Report results in writing.

1. A factory authorized service representative shall provide start-up service. Start-up to be performed only after complete water heater system is field verified and there is a full load and complete circulation.
2. Verify that the electrical wiring installation complies with manufacturer’s installations requirements.
3. Ensure pumps and operate properly. Start pumps, water heaters and adjust burners to maximum operating efficiency.
4. Measure and record temperature rise through each water heater.
5. Operate water heater, including accessories and controls to demonstrate compliance with requirements.
6. Train Owner’s maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting servicing and preventive maintenance.
7. Schedule training with Owner with at least 7 days advance notice.

END OF SECTION 22 30 00

Part 1. – GENERAL

1.1 SUMMARY

A. Contractor shall provide all labor and materials to provide a complete plumbing and fuel system for all fixtures and equipment shown on drawings. Contractor shall rough-in and make final connections to all fixtures and appliances supplied by others.

B. Contractor shall thoroughly review the manufacturer's installation instructions prior to installing any piece of equipment or its associated services, (domestic drains, water piping, etc.). Any conflicts between the manufacturer's installation instructions and the plans or specification shall be brought to the engineer at once for clarification. Contractor will not receive additional money for installations requiring modifications due to these conflicts.

C. All plumbing systems and products shall meet State and Local codes as well as ASNI, ASME and ADA requirements regardless of information shown within the documents.

D. This contractor shall provide a complete installation manual for each piece of equipment requiring electrical power/control connections scheduled to be performed by the Electrical contractor. This shall be done prior to any rough-ins by them to insure the proper power/control wiring has been provided. Notify the Engineer of any discrepancies between the installation manuals and the electrical plans and specifications for each piece of equipment.

Part 2. - PRODUCTS

2.1 GENERAL

A. Miscellaneous Plumbing Equipment:

1. Carriers for wall hung water closets, urinals and lavatories:
   a. Provide commercial grade carrier of approved style. Verify with General Contractor for type of wall construction and space prior to ordering carriers.
2. Fittings, Trim and Accessories:
   a. Install stop and escutcheon for each supply pipe, trap and escutcheon for each waste pipe and vacuum breaker supplied with hose attachments or integral with flush valve, or where water connection is below spill line of fixture.
3. Water Closet Seats:
   a. Resident Rooms: Church seat, #135TT, elongated seat, solid plastic open front without cover and molded-in bumpers.
   b. Public or Staff used Restrooms: Church seat, #295C elongated seat, solid plastic, open front, concealed stainless steel check hinges, molded-in bumpers and without cover.

B. Fixtures:

1. ACCEPTABLE MANUFACTURERS
   a. Lavatories: American Standard, Briggs, Kohler, Toto, Gerber, Mansfield, Zurn, Peerless Pottery, Eclipse, Sloan.
   b. Water closets: American Standard, Briggs, Kohler, Toto, Gerber, Mansfield, Zurn, Peerless Pottery, Eclipse, Sloan, ProFlo.
   c. Tub and shower: Best Bath System, Aquatic Bath, American Standard, Warm Rain/Embassy, Hamilton, Maax, Aquarius, Salo, Aqua Bath, Clairon Bathware and Oasis. **Note:** Grab bars and seats provided by General Contractor for field installation.
   d. Tub/Shower, lavatory and sink faucets: Delta, Symmons, Peerless, Moen, American Standard, Chicago Faucet, Crane, Eljer, Kohler, Speakman, T & S Faucets, Zurn, Gerber, ProFlo.
   e. Electric Water Coolers: Elkay, Halsey Taylor, Oasis, Sunroc, Haws, Acorn Aqua.

f. Mop sinks and laundry tub: Fiat, Mustee, Stern-Williams, Swan, Zurn, Jonespec, Gerber.
g. Stainless Steel Counter Sinks: Elkay, Just, LaCrosse, Dayton, Moen, Sterling, Advance-Tabco, Franke, Dayton.
h. Salon Sinks: Belvedere, Jeffco, Collins Concept.
i. Hose bibbs and Wall Hydrants: Chicago Faucet, T & S, Woodford, Josam, Wade, Zurn, Watts Drainage, MIFAB.
j. Toilet seats: Bemis, Beneke, Church, Olsonite, Sperzel, ProFlo.
k. Flush valves: Delany, Sloan, Zurn, Delta, Gerber, American Standard.
l. Carriers: Josam, Jonespec, J. R. Smith, Wade, Zurn, Watts.
m. Laundry Box: Guy Gray, Water Tite.
n. ADA Insulation Kits: Truebro, Plumberex, Handy-Shield.

Water Closets

2. Water Closet (P1) (ADA): American Standard Cadet, Pressure Assist, #2467.100 floor mounted, tank type, pressure assist, 2 1/8" trap way, 2" ball pass, 1.1 gpf, vitreous china, 17" high with seat, elongated rim, with bolt caps.
   a. 3" waste, 2" vent and 1/2" cold water.

Lavs

3. Vanity Lavatory (P2) (ADA): American Standard "Ovalyn" #0495.221, 17" x 14" oval vitreous china, undermount lavatory drilled for 4" centerset faucet.
   a. Trim: Delta #27C4822, two handle 4.5" goose neck spout, red/blue handle indicators, 1.5 gpm laminar flow aerator, offset open grid strainer. Provide ASSE 1070 mixing valve.
   b. 1 1/4" waste, 1 1/4" vent, 1/2" hot water and 1/2" cold water.
4. Vanity Lavatory (P2A) (ADA): American Standard "Ovalyn" #0495.221, 17" x 14" oval vitreous china, undermount lavatory drilled for 4" centerset faucet.
   a. Trim: Delta #27C4522, two handle 4.5" goose neck spout, red/blue handle indicators, 0.5 gpm laminar flow aerator, offset open grid strainer. Provide ASSE 1070 mixing valve.
   b. 1 1/4" waste, 1 1/4" vent, 1/2" hot water and 1/2" cold water.
5. Shower (P3): Aquatic #14836BFLP, overall dimensions 48"w x 36"d x 76"h, fiberglass reinforced polyester, smooth wall thru the floor drain installation and slip resistant floor. Shower walls shall be fully reinforced backed for on site installed grab bars. Coordinate color with Architect.
   a. Trim: Delta shower valve T17TH155-25C trim, valve body #R10000-UNWS for back to back installation, single handle, thermostatic, anti-scald with integral check stops. Field adjustable temperature limit stop. 1.5 gpm hand shower with 36" grab bar, 69" stainless steel hose, elbow and vacuum breaker. Provide shower drain strainer, body and trap.
   b. 2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.
6. Tub and Shower (P3A) (ADA Trim): Aquatic #2603SMTH, overall dimensions 60"w x 33"d x 81 "h. Dam height = 20". One piece unit, fiberglass reinforced polyester, smooth wall finish and slip resistant floor. Above floor rough-in, walls shall be fully reinforced backed for on site installed grab bars. Coordinate color with Architect.
   a. Trim: Delta shower valve T13TH2525-25C trim, valve body #R10000-UNWS for back to back installation, single handle, thermostatic, anti-scald with integral check stops. Field adjustable temperature limit stop. 1.5 gpm hand shower with 36" grab bar, 69" stainless steel hose, elbow and vacuum breaker. Provide pull up diverter spout. Provide waste and overflow.
   b. 1 1/2" waste, 1 1/4" vent, 1/2" hot water and 1/2" cold water.
7. Shower (P3B) (ADA): Tile shower by general contractor. Provide Sioux Chief 821-200PNQ shower drain and shower membrane.
   a. Trim: Delta shower valve T17TH155-25C trim, valve body #R10000-UNWS for back to back installation, single handle, thermostatic, anti-scald with integral check stops. Field adjustable temperature limit stop. 1.5 gpm hand shower with 36" grab bar, 69" stainless steel hose, elbow and vacuum breaker. Provide shower drain strainer, body and trap.
   b. 2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.
8. Shower (P3C) (ADA): Aquatic, #1603BFSB, overall dimension 62" x 36" x 77" , wheelchair roll-in, one piece smooth surface, fiberglass shower unit with gelcoat finish and slip resistant floor. Unit fully reinforced back for site grab bar installation. Provide a combination of ½" tri-cell laminate core and

½" plywood backing. Unit to have a ½" high threshold, when installed above finish floor. Provide 1 3/8" collapsible rubber water retainer.

a. Trim: Delta shower valve T17TH155-25C trim, valve body #R10000-UNWS for back to back installation, single handle, thermostatic, anti-scald with integral check stops. Field adjustable temperature limit stop. 1.5 gpm hand shower with 36" grab bar, 69" stainless steel hose, elbow and vacuum breaker. Provide shower drain strainer, body and trap.
b. 2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.

Kitchen Sinks

9. Kitchen Sink (P4): Elkay #LRAD292255 18 gauge type 304 stainless steel, self-rimming sink. Size 29" x 22" x 5 1/2" deep with double compartment, sound deadening undercoat, chrome cup strainers.
   a. Trim: Trim: Delta #27C4972-LS, two handle 6" goose neck spout, red/blue handle indicators, 1.0 gpm smooth end laminar outlet. Provide all required accessories.
   b. 1 1/2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.
10. Kitchen Sink (P4A): Elkay #LRAD131655 18 gauge Type 304 stainless steel, self-rimming sink. Size 16" x 16" x 5½" with single compartment, sound deadening undercoat, chrome cup strainer.
   a. Trim: Trim: Delta #27C4822, two handle 4.5" goose neck spout, red/blue handle indicators, 1.5 gpm laminar flow aerator.
   b. 1 1/2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.

Counter Sinks

11. Counter Sink (P5): Elkay #LRAD151755, 18 gauge Type 304 stainless steel, self-rimming sink. Overall size 15" x 17" x 5 1/2" with single compartment, sound deadening undercoat, grid strainer, 4" center set.
   a. Trim: Trim: Delta #27C4972-LS, two handle 6" goose neck spout, red/blue handle indicators, 1.0 gpm smooth end laminar outlet. Provide all required accessories and offset trap.
   b. 1 1/2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.

Service Sinks and Basins

12. Mop Basin (P6): Fiat MSB 24" x 24" X 10" molded stone floor sink. Provide with stainless steel strainer.
   a. Trim: Delta #28C2384, faucet chrome polished with rigid vacuum breaker spout, integral check stops, wall brace and wall hook, 3/4" hose thread and four arm handles.
   b. 3" waste, 1 1/2" vent, 1/2" hot water, and 1/2" cold water.
13. Laundry Tub (P6A): Fiat #L-1 white "molded stone", single compartment. Size 23" x 21" wall hung with a wall bracket. Complete with "P" trap.
   a. Trim: #A-1 chrome deck faucet, 4" centers. Non-threaded outlet.
   b. 2" waste, 1 1/2" vent, 1/2" hot water and 1/2" cold water.
14. Clinic Service Sink, floor outlet (P6B): American Standard #9504.010 with siphon jet action, flushing rim and 1-1/2 inch top spud.
   a. Trim: Faucet 8345.100, non-threaded outlet, wall mounted with brace, stops
   b. Trim: Pedal Valve 910-G777-21KCP self-closing foot pedals, stops, wall mounted with brace, vacuum breaker & hand held full flow sprayer with self-closing valves.
   c. Trim: Flush Valve Sloan 117H
   d. Trim: Bedpan cleaning assembly
   e. Trim: Stainless strainer
   f. 4" waste, 2" vent 1" cold water and 1/2" hot water.

Water Coolers

15. Water Cooler - two level (P7) (ADA): Elkay # LZSTL8WSSK barrier free, wall hung, bottle filler with capacity of 8.0 gph from 80º F to 50º F at 90º F ambient temperature, stainless steel top with front and side push bars to activate bubbler and baked enamel cabinet of color selected by Architect. Free of lead containing brass parts. Flexiguard safety bubbler. Provide cooler apron #LKAPREZL.
   a. 1 1/2" waste, 1 1/4" vent and 1/2" cold water.

Hydrants and Bibbs

16. Wall Hydrant (P8): Woodford #67C, field testable non-freeze loose key operated, with bronze finish and vacuum breaker.
   a. ¾" cold water.
17. Interior Hose Bibb (P8A): Chicago (inside wall faucet #952) (on wall faucet #998) with 3/4" hose threaded outlet, vacuum breaker and polish chrome plate.

a. ½" cold water.

Specialty Sinks

18. Shampoo Bowl (P9A): Belvedere Alpha 3800 #D575 Porcelain Bowl.
    a. Trim: Faucet with diverter, spray, strainer, vacuum breaker, tempering valve and neck rest. Coordinate color selection with Architect.
    b. 1 1/2" waste, 1 1/4" vent, 1/2" hot water and 1/2" cold water.

Miscellaneous

19. Washing Machine Wall Box (P11): Guy-Grey, B-200 20 gauge steel minimum with valved hose connections, vacuum breakers, water hammer arrestor and 2" drain connection.
    a. 2" waste, 1 1/2" vent, 1/2" hot water, and 1/2" cold water.
20. Refrigerator Ice Maker Outlet Box (P11B): Oatey #14K, high impact poly styrene, recessed in wall type, with ¼ turn brass ball valve.
21. Ice Machine (IM1) and Coffee Maker (CM1): Furnished by others. Final connections and vacuum breaker by mechanical contractor.
22. Flexible vinyl insulation system kit, Truebro Hand-lav Guard #102W with accessory #105. Install sink insulation kit on all exposed P-traps and water supplies.

Part 3. - EXECUTION

3.1 GENERAL

A. All exposed piping, supplies and stop valves shall be chrome plated brass unless indicated otherwise. No stops with internal supply lines and no plastic stop valves. Traps shall include chrome plated cast brass with clean-outs however, standard PVC traps for non-food service plumbing fixtures may be installed in non-rated walls. All water supplies to each fixture shall have chrome stop valves. Floor mounted water closets shall be connected using a cast iron floor flange and ring putty or gaskets. Wax gaskets are not acceptable for wall hung fixtures. Provide adequate supports and reinforcing for all wall hung fixtures, valves and shower heads. Install all fixtures rigid, plumb and true.

B. Grout and caulk all fixtures with water and mildew resistant white epoxy shall be Hydroment or Dow Corning No. 786. Grout shall not exceed 1/4" width and shall be installed flush with finished wall or floor.

C. All fixture installation dimensions shall be determined from the Architectural documents. Plumbing fixture colors to be selected by Architect.

D. P-Traps and water supplies insulate per ADA, ANSI and Washington Accessibility.

E. Controls for ADA flushing water closets shall be mounted on the wide or most accessible side of the water closet.

F. Provide locking style valves in any lines serving an emergency eyewash or shower.

G. All shower and bathtub waste shall be Schedule 40, one piece PVC glued or one piece cast iron trap with cast brass pipe soldered connection.

END OF SECTION 22 40 00

SECTION 23 00 10
GENERAL CONDITIONS

Part 1. - GENERAL

1.1 SUMMARY

A. These plans and specifications constitute a 50% set of documents. It is the Contractor's responsibility to include all miscellaneous items in all areas necessary for complete and functional systems for this type of a facility. The successful Contractor shall complete the design of each system per Code. The final plans and specifications shall be signed by a professional engineer registered in the State where the project is being constructed.

B. General and Supplementary conditions within Division 0 and 1 are hereby incorporated and become part of these Specifications, covering all work in Mechanical Division.

C. Before submitting a proposal on the project, the Contractor shall visit the site and familiarize themselves with the conditions and limitations affecting Mechanical Division work. No additional costs to the Owner shall be allowed for items verifiable during site visits.

D. Contractor shall provide sufficient workers and materials to keep pace with the construction schedule. Contractor shall place orders for equipment such that job progress is not slowed due to late delivery and shall confirm delivery dates with suppliers.

E. The Contractor shall provide office space and storage for materials and equipment supplied. Location shall be as directed by the General Contractor or the Architect/Engineer.

F. Upon completion of the work shown and specified under Mechanical Division and prior to final close out of the Project, the Contractor shall verify in writing that all systems are 100% complete and operating properly. This notification shall include copies of all Subcontractor notifications. Any system not operating properly at final inspection shall be immediately repaired and demonstrated to the Engineer.

G. Rebates or credits provided by utility companies or equipment manufacturers shall be directly credited to the Owner. The Contractor shall identify, coordinate and manage applications for these rebates or credits.

H. The Contractor shall electronically record all training sessions called for within other specification sections and include a copy of each within the Operations and Maintenance Manuals.

1.2 MECHANICAL PLANS

A. The Mechanical Drawings and Specifications shall form a set of Plans for the mechanical work. Neither the Drawings nor the Specifications shall be complete without the other. Any item shown on the Drawings or specified in the Specifications shall be considered as shown and specified on both.

B. Any questions regarding the intent of the Drawings or Specifications shall be brought to the Engineer's attention as soon as possible. If direction from the Engineer cannot be obtained due to time or communication limitations, the greater quantity, higher quality or condition most favorable to the Owner shall be assumed. Contractor shall provide all labor, materials, equipment, and miscellaneous items necessary for a complete and operational mechanical installation, as shown on the Drawings and called for in these Specifications.

C. Drawings:

1. Contractor shall familiarize themselves with Architectural, Structural and Electrical Drawings and Specifications. Coordinate all shafts, chases, furred spaces, suspended ceilings, locations of equipment, etc.

2. Mechanical Contractor shall coordinate routing of all piping and ductwork within soffits provided by the General Contractor. The Mechanical Contractor shall provide all soffiting required to cover installations not coordinated or specifically approved by the Architect and Engineer.
3. Mechanical Drawings are diagrammatic and are intended to show approximate location only. Placement of mechanical equipment and devices shall not interfere with locations or clearances of other trades' materials or equipment.
4. Contractor shall verify locations with architectural elevations.
5. Dimensions given on the Drawings shall take precedence over scaled dimensions. Dimensions, whether given in figures or scaled, shall be verified in the field.
6. Contractor shall verify that the equipment to be furnished under Contract will fit within the available space.
7. Notify the Architect and Engineer of any discrepancies between Electrical, Architectural and Mechanical Drawings.
8. Verify items such as door swings, window locations, casework, etc., before installing any mechanical equipment or devices. All devices conflicting with other trade's work due to lack of coordination shall be relocated at no additional cost to the Owner.

D. The following terms used in the Drawings and Specifications shall be defined as follows:

1. Contractor: Shall mean Mechanical Contractor or any of their Subcontractors.
2. Work: Shall mean labor and/or materials of the Mechanical Contractor or any of their Subcontractors.
3. Furnish: Shall mean purchase, submit for Engineer approval, coordinate with Contract Documents and deliver to site in new, undamaged condition.
4. Connect: Shall mean to bring mechanical service and/or control wiring to equipment, make all final connections, provide all necessary miscellaneous materials required and do final check out to ensure proper equipment connections.
5. Install: Shall mean to store as directed, protect from damage, set in place, connect, test and turn over to the Owner in full operating condition.
6. Provide: Shall mean furnish and install.

E. Electronic Design Files:

1. Mechanical electronic files prepared by Steen Engineering, Inc. for this Project are instruments of Steen Engineering, Inc. for use solely with respect to this Project. During the course of the implementation of the Project, and with Steen Engineering, Inc. approval, copies may be obtained of electronic files for the preparation of Shop Drawings. These electronic files shall not be used on other projects, for additions to this Project, or for completion of this Project by others. Any revisions, additions and/or deletions to these electronic files, either intentional or unintentional, shall be made at the full risk of the person(s) making such revisions, additions and/or deletions. Such person(s) shall hold harmless and indemnify Steen Engineering, Inc. of any and all responsibilities and liabilities.
2. Electronic files of Architectural floor plans, elevations, sections, etc, shall be requested directly from the Architect.

1.3 COORDINATION OF DRAWINGS

A. For typical or repetitive HVAC unit installations, contractor shall schedule an inspection with local and/or state AHJ to review a complete mock-up example installation and receive approval prior to proceeding with additional installations. Installation shall meet all code and manufacturer's service clearance requirements. Contractor shall coordinate installation and subsequent inspection with general contractor and any related trades.

B. Contractor shall submit a ¼-inch scale drawing to the Engineer indicating placement of all mechanical and electrical systems and equipment. Indicate proposed locations of all major equipment and materials, including but not limited to service equipment, exterior wall and foundation penetrations, fire-rated wall and floor penetrations, sizes and location of required concrete pads and bases, and mechanical/electrical

equipment room layouts. This effort will require each trade to closely work together to produce a ¼-inch set of coordination drawings for each area of the building.

C. Coordinate scheduling and sequencing required for movement and positioning of large equipment into the building with all other Contractors to minimize impact on their work.

D. This Contractor shall provide any and all input required to complete these drawings.

1.4 MATERIALS AND EQUIPMENT

A. Materials:

1. All materials shall be new and of the type and quality specified herein.
2. Specific materials and equipment specified is intended to establish a minimum standard of required quality. Where specified materials and equipment fail to meet minimum standards of existing federal, state and local codes and ordinances, the governing codes and ordinances shall prevail.
3. The Contractor shall provide all minor miscellaneous materials necessary for the complete mechanical installation.
4. For materials and equipment specified by description only, the Contractor shall provide materials or equipment suitable for the purpose intended. These shall be in conformance with all governing codes, these Specifications and normal trade practice.
5. Supply materials and equipment to the site in original packages, containers or crates insofar as is practical. It shall be the Contractor's responsibility to schedule deliveries in accordance with the overall Project schedule. The Contractor shall closely coordinate all deliveries with other Contractors and the Engineer.
6. Provide for proper receipt, handling, storage, and protection from the elements for all materials and equipment to be used on this Project so as to effectively prevent damage or deterioration. Materials or equipment sustaining damage or undue deterioration from any cause whatsoever shall be replaced or repaired by Contractor.
7. The Contractor shall properly protect all equipment from damage during construction. Thoroughly clean all fixtures, equipment and other supplied materials. Make all necessary repairs and apply touch up paint prior to final inspection and contract close out.
8. All materials and equipment shall be listed by Underwriters' Laboratories, Inc. (UL). Materials and Equipment shall meet the UL requirements of each standard in every case where such a standard has been established for that particular type of material. Equipment shall be UL listed as an entire assembly or system.

B. Prior Approvals:

1. All requests for prior approvals must be received by the Engineer at least seven working days prior to bid date. Applications for prior approval shall be considered only from Contractors submitting bids on the Project. Contractors shall determine whether materials receiving prior approval are actually in accordance with details of the Specifications.
2. The Contractor shall be responsible for all deficiencies, design or performance related differences that may exist from the use of substituted products or equipment, including all additional labor and materials required to complete the work. **A substituted product refers to and includes any prior approved manufacturer or any manufacturer that differs from that equipment which is scheduled.** All dimensions and characteristics of substituted products shall be verified and coordinated with all affected trades and Subcontractors. Any required changes or modifications to the work of any other trade or Subcontractor incurred due to using accepted substituted products shall be coordinated and performed by this Contractor at no additional cost to the Owner.

1.5 SUBMITTALS

A. Within fifteen days after the award of the Contract, the Mechanical Contractor shall submit shop drawings on all major mechanical equipment to the Architect for approval. Shop Drawings shall be submitted by the

Mechanical Contractor, not their Subcontractors. **Shop drawings shall be submitted separately per specification section. Multiple shop drawing sections received in a single submittal will be rejected.** These shop drawings shall cover such items as boilers, chillers, pumps, fittings, valves, plumbing fixtures, dampers, AHUs, fintube, exhaust fans, MUAs, diffusers, water heaters, water softeners, fire protection, etc. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed and dated indicating Contractor review. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis. No equipment shall be released for shipment or installed prior to final approval by the Engineer.

B. The Engineer will review all Shop Drawings submitted and will retain one copy for record file.

C. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required for complete and functional systems. Submittals will be reviewed with the following actions:

1. "No Exception Taken" indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.
2. "Revise per Comments; No Resubmittal Required" indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without an increase in Contract Sum or Time.
3. "Revise and Resubmit" indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
4. "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.
5. "Copy Retained for Record Only" indicates the submittal is retained for reference only and is not reviewed for conformance with the Contract Documents.

D. If the Engineer rejects "Revise and Resubmit" or "Rejected"," the same section two times the engineer shall be compensated for additional reviews. Compensation will be incorporated by Change Order and will be deducted from the Contractor's application for payment. Contractor is responsible for all delays caused by the resubmittal process.

E. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

F. Record Drawings: The Contractor shall provide and maintain an "As Built" set of bluelines on site, neatly notating routing, location or other field changes to the Contract Documents. Upon Project completion and prior to final close out, turn the "As Built" drawings over to the Owner. Provide a detailed transmittal indicating each sheet and other information turned over to the Owner and acquire their representative's signature. This information shall be included at the project close out.

1.6 WORKMANSHIP AND CONSTRUCTION PROCEDURES

A. Installation of all materials specified herein shall be performed in a neat and workmanlike manner by workers experienced and skilled in the trade. Only the best quality workmanship will be accepted.

B. The Contractor shall regularly clean their work area of debris. Removal of all Contractor generated debris and rubbish caused by their work shall be at the Contractor's expense.

C. Contractor shall coordinate with the Owner any interruptions necessary to existing systems prior to shut down.

D. Coordination:

1. Contractor shall give careful consideration to work of other Contractors on the Project and shall organize work as detailed in the Contractor's ¼" coordination drawings so as to not interfere with or delay the work of other trades.
2. This Contractor shall provide a complete installation manual to the Electrical Contractor for each piece of equipment requiring electrical power/control connections scheduled to be performed by the Electrical Contractor. This shall be done prior to any rough-ins by the Electrical Contractor to insure proper power/control wiring has been provided. Notify the Engineer of any discrepancies between the installation manuals, the electrical plans and the mechanical specifications for each piece of equipment.
3. Contractor shall consult all Architectural, Structural and Electrical Drawings and Specifications that apply for correlating information.
4. Conflicts or interference with work of other trades shall be brought to the attention of the Engineer, in writing, before installation.
5. Should the Mechanical Contractor not follow above procedures and install work that interferes with work of other Contractors, the Mechanical Contractor shall make all necessary changes as directed by Engineer to eliminate the interference or conflict at the Mechanical Contractor's expense.

E. Protection of Equipment:

1. Until final acceptance of the work by the Owner, the Contractor shall be responsible for the safety, good condition, and protection from damage of all materials and equipment installed.
2. If, during shipment or installation, the finish of equipment becomes chipped or scratched, the Contractor shall touch up or refinish surfaces to match original finish.

F. The Contractor shall complete all safety forms required by General Contractor.

1.7 LICENSES, CODES AND FEES

A. The Contractor shall be a licensed Contractor in the State where the project is being constructed. The Contractor shall employ all Licensed Professional Tradesmen required for each type of work covered under these Drawings and Specifications.

B. The Contractor shall procure all necessary certificates and permits and pay all required fees. The Contractor shall pay all fees and installation charges by the utility company for the permanent services.

C. Codes and Ordinances: All work and materials shall meet the requirements of national, state and local codes and ordinances, in every respect. This requirement shall not relieve the Contractor from meeting the requirements of Drawings and Specifications that may be in excess of all codes and ordinances and not contrary to them.

D. Inspections: Regular inspections shall be requested by the Mechanical Contractor to meet all state and local requirements. Contractor shall furnish a certificate of final inspection and approval from all enforcement agencies to the Owner.

1.8 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver two sets of Operation and Maintenance (O&M) manuals to the Owner prior to final close out. O&M manuals shall consist of approved shop drawings, manufacturer's bulletins, equipment manuals, a list of manufacturers with telephone numbers for all equipment that contains replaceable parts,

training videos and all other data covering the care, maintenance and operation of each piece of furnished equipment. O&M manuals shall be neatly bound in 3-ring binders, contain an index and section tabs and be labeled with the Project name.

B. Name, address, and telephone number of each Contractor installing equipment and systems, local representative for each item of equipment and each system. Table of contents shall correspond to the Specifications with the Section tab sheets placed before the respective Shop Drawings and operation and maintenance instructions.

1. Warranties for more than 1 year shall be included in appropriate section.
2. A maintenance and lubrication schedule shall include each motor, function, control location, fuse location, belt sizes type of lubricant, and rate of lubrication in accordance with manufacturer.
3. A filter maintenance schedule shall include filter size and quantity for each unit, located by room number.

1.9 OPERATING INSTRUCTIONS AND TESTING

A. The Contractor shall fully instruct the Owner in the operation of mechanical equipment prior to final close out. Contractor shall provide, without additional expense to Owner, services of competent instructors who will give full instruction in the care, adjustment, operation and maintenance of all mechanical systems provided by this Contractor to Owner's permanent employees. Instructor shall be thoroughly familiar with all parts of the installation that they are to give instructions and shall be trained in operating theory, as well as in practical operation and maintenance work. Factory trained instructors shall be employed wherever they are available. Instruction shall be given during regular work week and at a time just prior to the time the equipment is accepted and turned over to Owner for regular operation.

B. The Contractor or his representative shall provide a minimum of five days instruction period for Owner's personnel.

C. Contractor shall test all equipment installed under this Specification and shall demonstrate its proper operation to the Engineer. No equipment shall be tested or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment due to improper or ill-timed operation or testing shall be repaired, at Contractor's expense, before final inspection and acceptance.

1.10 WARRANTY

A. The Contractor shall guarantee all materials and equipment to be free of defects that may develop in any part of their work, caused by faulty workmanship, material or equipment failures, for a minimum of one year from the date of final completion of the Project or for as long as normal equipment manufacturer warranties are in effect from the date of final completion of the Project, whichever is later.

B. During the guarantee period, notification by letter, personal contact or telephone conversation of a problem with any mechanical system, shall cause the Contractor to respond within one week, making repairs or corrections. After all repairs and corrections are complete, the Contractor shall notify the Engineer.

C. During the guarantee period, the Contractor shall agree to provide 24 hour service on call for emergency.

Part 2. – PRODUCTS

N/A

Part 3. - EXECUTION

N/A

END OF SECTION 23 00 10

SECTION 23 00 50
BASIC MATERIALS AND METHODS

Part 1. - GENERAL

1.1 SUMMARY

A. Work included under this Division shall consist of furnishing labor and materials necessary for the installation of the work called for under the Mechanical, Fire Sprinkler Protection, Temperature Control and Mechanical Test & Balance contracts as listed in the Instruction to Bidders, as specified, and as shown on Drawings to provide a complete, operable and approved system.

1.2 REFERENCES

A. The following is a partial list of related standards:

1. Air Conditioning and Refrigeration Institute (ARI).
2. American National Standard Institute (ANSI).
3. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).
4. American Society of Mechanical Engineers (ASME).
5. American Society for Testing and Materials (ASTM).
6. Air Moving and Conditioning Association (AMCA).
7. Manufacturer's Standardization Society (MSS of the Valve and Fittings Industry, Inc.).
8. National Electrical Manufacturers Association (NEMA).
9. Plastic Pipe Institute (PPI).
10. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
11. Steel Tank Institute (STI).

1.3 QUALITY ASSURANCE

A. Where equipment is specified by manufacturer, brand name or catalog number, this shall establish the standard of quality and style of the product to be provided under the Contract.

B. Where two or more units of the same kind of equipment are required, they shall be products of a single manufacturer. Mixing and matching of various manufacturer's like or similar components shall not be permitted.

C. The Contractor shall field verify and inspect existing buildings for connections to existing systems, equipment, and materials designated, on Drawings or in Specifications, to be used.

D. The Contractor shall have full responsibility of component parts of the mechanical system to ensure that new equipment, integrated with existing equipment and systems, will perform and operate in accordance with requirements of the Specifications without excessive or unusual service or maintenance requirements.

E. The Contractor shall be responsible for verifying locations of such things as piping, ductwork, equipment, door swings, heights of cabinets and counters, etc., prior to the installation of any mechanical equipment. Installed mechanical work that interferes with the work of other trades shall be relocated by the Mechanical Contractor at no additional cost to the Owner.

F. Contractors shall coordinate with all other trades and install their systems in the space provided/coordinated within the structure. Install systems and materials for ease of maintenance. Equipment arrangements shall provide at least the minimum clearances as recommended by equipment manufacturer to facilitate proper maintenance and servicing of system. Deviations in minimum clearance requirements shall be permitted only

upon prior written authorization from the Architect/Engineer.

Part 2. - PRODUCTS

2.1 FIRE BARRIER PENETRATION SEALING SYSTEMS:

A. Approved Manufacturers: Hilti, 3M, Transco Products, Nelson Flameseal Systems, Tremco, Inc..

B. Firestopping materials shall conform to local building code requirements and shall be tested according to UL 1479 and ASTM-E84 for through-penetration firestop systems.

C. Firestopping materials shall be furnished by a supplier who specializes in the selection and furnishing of firestopping materials for building systems.

D. Submit shop drawings including a penetration protection schedule which lists each fire resistive construction type for this project, its fire rating, item penetrating and insulation (if any) UL through-penetration firestop systems number, manufacturer and model numbers. Include installation diagrams and product data sheet.

E. Contractor shall submit all fire stopping methods to Local Authorities for approval. Provide copies of all approved fire stopping methods to the Engineer. Seal all penetrations and sleeves through floors and fire walls with high temperature, fire rated sealant. Fire stop material shall be 3M brand Fire Barrier Penetration System. In lieu of type system described above, modular component system shall be ProSet System Inc. may be utilized. Install the appropriate concrete or wood penetration system to comply with Code.

2.2 WALL, FLOOR, AND CEILING OPENINGS

A. General Requirements:

1. Contractor shall be responsible for exact sizes and locations of chases and openings required for mechanical work.

B. Chases and Openings:

1. General Contractor shall leave chases and openings in walls, floors, ceilings, and partitions where shown on Drawings or otherwise necessary to receive mechanical work. It is this contractor’s responsibility to coordinate sizes and locations prior to framing, pouring or setting of precast.

2.3 SLEEVES

A. General Requirements:

1. Provide sleeves in conjunction with water tight piping passing through concrete or masonry walls, partitions, and slabs. Provide sleeves in mechanical equipment rooms and chases to prevent water flooding from floor to floor in addition to separating piping from building structure.
2. Sleeves shall extend 3” beyond the full thickness of walls and slabs and shall be at least 2 pipe diameters larger than or 2” larger than ducts piping passing through. Where piping with covering is installed, a minimum of 1” shall be provided between outside of pipe covering and inside surface of the sleeve.

B. Duct Sleeves:

1. Material: Except as otherwise indicated, duct sleeves shall be constructed of minimum 22 gauge galvanized iron.
2. Vertical Sleeves: Vertical duct sleeves through floors shall have space between duct and sleeve packed with an approved fire stop material flush with top of sleeve to make a fire rated and watertight joint. Insulated duct shall have foamed rubber insulation full length within sleeves.
3. Placement: Set sheet metal sleeves for ductwork passing through floors above grade. Sleeve shall extend 3-inch above finished floor elevation. Sleeve shall be supported in place before floor is poured and shall be caulked to make a waterproof joint between floor and sleeve. Where more than one duct is passing through a floor slab above grade and one floor opening for all ducts is provided, sleeve shall be same size as the overall opening.
4. Interior Sleeves: Ductwork through walls shall have soundproof packing in non-rated wall sleeves and an approved fire stop material in fire rated wall sleeves. Ducts passing through corridor walls not containing fire dampers shall be sleeved.
5. Exterior Sleeves: Ductwork passing through exterior walls shall be sleeved and caulked watertight. Exterior ductwork shall be so installed as to pitch away from wall penetration a minimum of ¼-inch per foot.
6. Fire Rated Wall and Floor Openings: Ductwork passing through fire rated walls and floors shall be provided with an Underwriters' Laboratories listed duct and sleeve assembly. Duct and sleeve assembly shall meet or exceed fire rating of wall and floor through which the duct passes.

C. Pipe sleeves:

1. Exterior Walls: Sleeves shall be standard weight steel pipe. Install sleeves in exterior walls and floors below grade with approved caulking between sleeves and piping to make it waterproof. Plastic sleeves shall not be used.
2. Floors: Sleeves shall be standard weight steel pipe. Vertical pipe sleeves through floors shall have space between pipe and sleeve packed with an approved fire stop material flush with top of sleeve to make a watertight and fire rated joint.
3. Interior Sleeves: Sleeves shall be standard weight steel pipe. Piping through walls of adjacent rooms shall have soundproof packing in non-rated walls and an approved fire stop material in fire rated walls.
4. Fire Rated Wall and Floor Openings: Piping passing through fire rated walls and floors shall be provided with an Underwriter’s Laboratories, Inc. listed pipe and pipe sleeve assembly. Pipe and pipe sleeve assembly shall meet or exceed fire rating of wall and floor which the pipe passes through.
5. Contractor shall provide all sleeves required through footings, foundation walls and floors. Underground water services as indicated on plans shall be sleeved with schedule 40 PVC sleeving. Sleeve to be (1) size larger than the pipe it serves. Extend sleeves 0’-3” beyond penetration. Coordinate with Structural Engineer.

2.4 ACCESS PANELS

A. The Contractor shall provide means of access for all equipment, smoke/fire dampers, fire damper, valves and fittings specified to comply with Local Code. Furnish wall and ceiling access panels to the General Contractor for installation. Access doors and panels required within rated separations shall carry the appropriate rating. Conform to Division 8 access panel specifications. Contractor to provide separate per unit price per access panel for pricing purposes.

Part 3. - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. On-Site Review: Contractor shall visit site to become thoroughly acquainted with existing conditions of site and services.
2. Existing Active Services: When encountered during construction, Contractor shall protect, brace or support pneumatic tubing, existing active sewers, water, gas, ductwork, or other services for proper execution of Work.
3. Inactive Services: If encountered during construction, Contractor shall cap or plug inactive pipes, ducts, and temperature control tubing or wiring at no additional cost to Owner.
4. Responsibility: Liability for repairs or replacement of damaged or defective materials, including, but not limited to, property damage resulting from negligence or other causes, shall be the Contractor's sole responsibility until work has been accepted by Architect/ Engineer and Owner.

3.2 PREPARATION

A. Protection: After delivery, and before and after installation, equipment shall be protected against theft or damage.

1. Contractor shall protect plumbing fixtures, metal heating enclosures and other equipment and all baked enamel or glazed surfaces from damage by covering or coating as recommended in Bulletin, "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by Plumbing Fixture Manufacturers Association or by other methods approved by Architect/Engineer.
2. Coat polished or plate metal parts with vaseline immediately after installation. Protect equipment outlets, pipe and conduit openings with temporary plugs, caps or burlap to prevent filling with construction dirt.

3.3 EXCAVATION AND BACKFILL

A. Excavation: Contractor shall perform excavation boring, drilling, back filling and compaction at required depth for installation of work indicated or specified.

1. Excavated material not required or not suitable for backfilling shall be removed from site.
2. Protect excavation by grading and pumping to keep space clear of water during construction.
3. Provide shoring and sheeting as necessary for protection of work and safety of personnel. Protect bottom of excavation from frost.
4. Excavation in rock shall be 8-inch below invert of pipe to be installed and shall be backfilled to a depth of 8-inch with clean, washed sand before pipe installation.
5. Excavation terminating in unstable or organic material at pipe invert elevation shall be continued to 30-inch below pipe invert elevation and backfilled with pit run gravel to pipe invert. Soil boring reports are available for inspection at Architect's office.
6. Pipe installation in backfilled areas shall not occur until backfill is 2 feet above pipe invert, at which time backfill shall be excavated to proper depth, pipe installed, and backfill replaced as specified.
7. All lines are to be properly capped to prevent the entrance of dirt or any other foreign matter. All debris and water shall be removed from the trench prior to final installation. Properly protect piping or ductwork until backfilling can be performed. Inspection of all installations by Local Inspection Authorities shall be completed prior to backfilling.

B. Backfilling Under Floors and Slabs: Backfill areas below concrete slabs on grade in horizontal layers not to exceed 8-inch in depth and compact with approved equipment until dry density is not less than 95 percent of Standard Proctor Density.

1. Backfill material shall be pit run gravel or coarse sand free of rubbish, compacted and leveled to receive slab. If natural earth is of similar structure with same material as specified above, no additional material will be required. Fill to raise subgrades to required elevation shall be accomplished as specified above.
2. Materials and methods of compaction shall be approved by Architect/Engineer before start of work.

3. Areas not below concrete or asphalt slabs and footings shall be backfilled with suitable excavated material, free of debris and rubbish.
4. Carefully backfill to a point 6" above piping or ductwork and thoroughly tamp. Complete backfilling in 8" lifts and compact each layer to 98% standard proctor density. Restore surface to its original condition, i.e. grass, concrete, blacktop, etc.
5. Contractor shall pay costs for testing of compacted backfill by an approved testing laboratory when tests are requested by Architect/Engineer.

C. Backfilling Outside: Backfill excavations below finished grades with materials similar to that removed in excavation, free from rubbish or other unsuitable material. Place backfill and compact to prevent settling.
1. Backfilling shall be done to finished grades indicated on Drawings. If no finished grading is done in excavated areas, Contractor shall backfill to existing grades and restore surface to original condition.
2. Compaction over ditches less than 3 feet in width and around walls and columns shall be done by the use of mechanical hand compactors.
3. Contractor shall pay costs for testing of compacted backfill by an approved testing laboratory when tests are requested by Architect/Engineer.

D. Pavement, Curb, and Sidewalk Replacement:

1. Contractor shall be responsible for the replacement of existing street pavement, curbs and sidewalks removed or damaged by Contractor or related subcontractors.
2. Make necessary arrangements to perform such repairs and pay incurred costs in connection with said repairs, including amount in Bid.

3.4 CUTTING AND PATCHING

A. Cutting and patching shall be held to practical minimum consistent with good construction practice by properly locating and leaving sleeves and boxes, or notifying General Contractor of openings, where required, as construction progresses. All cutting and patching shall be done with the prior approval of the Architect/Engineer.

1. Necessary cutting and patching of walls, floors, partitions and ceilings for the proper installation of work under this Contract, shall be the sole responsibility of this Contractor. Perform cutting and patching in such a manner as to leave no visible trace and to return the part affected to the condition of undisturbed work. Cutting and patching shall be performed by men experienced, skilled, and licensed for the particular type of work involved. Inferior work will not be accepted.

B. Pavements and Concrete: Cutting shall be accomplished by saw cutting a minimum of 1 ½-inch deep prior to jack hammering. Contractor shall bore below the surface where indicated on Drawings or where required by Architect/Engineer.

C. Repair: Patch pavements and concrete to match existing conditions. All labor and materials required to replace and repair sections cut or damaged shall be furnished and installed by this Contractor.

3.5 INSTALLATION

A. Connection to Equipment Specified: Provide material and labor required to connect to the mechanical system of fixtures and equipment having mechanical connections and which are specified in other Sections or Divisions of the Specifications or furnished by Owner.

1. Provide piping supply connections with shut-off valves.
2. Ductwork connections to equipment, diffusers, and appurtenances shall be made with flexible ductwork

unless a solid connection is indicated.

3. Drainage connections shall be properly trapped and vented.

B. The Mechanical Contractor shall provide concrete pads for all floor mounted equipment. Pads shall be 4" thick and extend a minimum of 2" beyond equipment.

C. Mechanical Contractor shall provide angle iron stands for all gas fired equipment located on the same level or below any enclosed parking garage floor where the mechanical room opens to that same level. Stands shall elevate burners above 18" or to comply with Local Code. This includes all MUA units, furnaces, water heaters, boilers, etc. Verify exact requirements with the Local Inspector prior to performing any fabrication.

D. Floor, Wall and Ceiling Plates:

1. Where uncovered exposed pipes pass through floors, walls or ceilings in finished rooms and inside casework, fit with approved type chrome plated metal plate.
2. Plastic escutcheon plates shall not be permitted.

E. Mechanical Systems Painting: Exposed supporting iron and steel work, bare pipe, fittings, hangers, and supports shall be wire brushed, washed with mineral spirits to remove dirt and grease, and painted with one coat of metal primer followed by two finish coats of battleship gray paint.

F. Concealed Equipment location: Location of motor operated equipment, furnished under this Contract, installed above ceiling shall be identified by placing a color coded thumb tack (or adhesive applied dot) in the ceiling directly below item noted. Identification colors shall be as follows:

1.	Exhaust Fans:	Green
2.	Air Handling Units:	Blue
3.	Control Valves:	Yellow
4.	Shut-off Valves:	Orange
5.	Fan Coils:	Red

G. Filtration: At time of substantial completion, and prior to turning equipment over to Owner, Contractor shall install a complete set of unused, clean filters in each type of unit supplying filtered air to the building.

3.6 IDENTIFICATION

A. Exposed Piping: Bare and insulated, exposed new piping in Boiler Room, Mechanical Rooms, and unfinished rooms shall be identified with labels, painted on using metal stencils. Stencils shall have 1-inch high letters and shall include a directional arrow 3-inch long by 1/2-inch wide, indication direction of flow. Color of stenciling shall be black lettering on a yellow background.

1. Labels shall be located at each change in direction of pipe runs and at intervals not to exceed 20 feet.
2. Setmark snap-on pipe markers by Seton Nameplate Corporation or snap-on pipe markers by W. H. Brady Company, which are similar to above stencil description shall be acceptable.

B. Concealed Piping: Bare and insulated new piping running in ceilings and soffits shall be identified with labels painted on using metal stencils. Each stencil shall have 1-inch high letters and shall include a directional arrow 3-inch long by 1/2-inch wide indicating direction of flow. Color of stenciling shall be black lettering on a yellow background.

1. Labels shall be located at each change in direction of pipe runs and at intervals not to exceed 20 feet.
2. Labels shall be located on each side of wall, partition and floor penetrations.

3. Setmark snap-on pipe markers by Seton Nameplate Corporation or snap-on pipe markers by W. H. Brady Company, which are similar to above stencil description shall be acceptable.

C. Pipe Markers: Contractor shall label the piping as follows:
1. Condensate Drain CD

D. Equipment: All scheduled equipment under this Division shall be identified with stamped labeled placards matching the scheduled identification tags and adhere directly to the equipment.

E. Controls: Controls and switches furnished under this Divisions shall be clearly labeled and identified.

F. Rated Dampers:

1. All rated fire, smoke and combination smoke/fire dampers shall be numbered and clearly labeled at ceilings and/or walls with ½" lettering. At duct penetrations in exposed areas, labels may apply directly on damper assembly or ductwork in a conspicuous location. For dampers located in floor penetrations, identification labels shall be at corresponding wall/ceiling access panel.

3.7 CLEANING

A. Housekeeping, Cleaning and Storage: Remove from the building and site, scrap material, temporary building, packaging material, miscellaneous debris, and dirt on a regular schedule and in accordance with Architect/Engineer's direction, to maintain building in a reasonably clean, workable condition during construction.

1. Cutting oil and steel shavings shall be caught in a suitable container to ensure final finish material in building will not be marred or damaged.
2. Upon completion of work and before final inspection, Contractor shall remove plaster, paint, rust, stickers, and shipping tags from installed equipment.
3. Clean foreign matter from installed equipment and remove dirt and debris, in connection with work, from building.

3.8 PRE-OPERATIONAL SYSTEM CLEANOUT

A. Pre-Cleaning Chemicals: New piping systems and appurtenances shall be cleaned with a one percent solution of Ferrosol 345, neutral pH cleaner to remove any iron deposits, oil-based coatings, mill scale and construction residues.

1. Follow manufacturers' directions regarding equipment.

B. Cooling and Heating Water Systems: The chiller, condenser and chilled water lines and related cooling equipment, boiler, heat exchangers, heating piping and related heating equipment shall be thoroughly flushed out with precleaning chemicals, as called for above, designed to remove deposits such as pipe dope, oils, loose rust, mill scale and other extraneous materials.

1. Add recommended dosages of manufactured and blended pre-cleaner chemical products and circulate throughout the water system. Drain, fill and flush water systems until no foreign mater is observed and the total alkalinity of the rinse water is equal to that of the make-up water.
2. Clean strainer screen after each flush and furnish and install new strainer screens prior to filling system for operation.

END OF SECTION 23 00 50

SECTION 23 05 00
TESTING AND BALANCING

Part 1. – GENERAL

1.1 SUMMARY

A. Section includes testing, adjusting, and balancing of air, plumbing and natural gas systems, testing, adjusting, and balancing of mechanical systems, measurement of final operating condition of HVAC systems, sound measurement of equipment operating conditions, vibration measurement of equipment of operating conditions.

1.2 REFERENCES

A. AABC (Associated Air Balance Council)-National Standards for Total System Balance.

B. ASHRAE 111 (American Society of Heating, Refrigerating and Air Conditioning Engineers). Practices for Measurement, Testing Adjusting and Balancing of Building, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

C. NEBB (National Environmental Balancing Bureau). Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. TABB (Testing, Adjusting and Balancing Bureau). International Standards for Environmental Systems Balance.

1.3 DEFINITIONS

A. TAB: Testing, Adjusting, and Balancing. The process of checking and adjusting HVAC systems to meet design objective.

B. Basic TAB terms used in this Section: Chapter, “Testing, Adjusting and Balancing” of ASHRAE Handbook, latest Applications Volume.

1.4 SUBMITTALS

A. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, forms prepared following ASHRAE 111, TABB/SMACNA or NEBB Report forms.

B. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

C. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

D. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

E. Provide reports in bound manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

F. Include detailed procedures, agenda, sample report forms and a copy of either AABC National Project Performance Guaranty or NEBB Certificate of Conformance Certification prior to commencing system balance.

Part 2. - PRODUCTS

N/A

Part 3. - EXECUTION

3.1 GENERAL

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Ventilation Systems:

    a. Final filters are clean and in place. If required, install temporary media in addition to final filters.
    b. Duct systems are clean of debris.
    c. Fans are rotating correctly.
    d. Fire and volume dampers are in place and open.
    e. Access doors are closed and duct end caps are in place.
    f. Air outlets are installed and connected.
    g. Air coil fins are cleaned.

B. When the work has been completed, balance the air flow from each diffuser and register in accordance with the recommendations of the diffuser manufacturer, setting dampers, controls and/or other volume control devices in such a manner as to produce the air flow rate indicated on the drawings. Test to the satisfaction of the Engineer to insure for satisfactory operation of all equipment:

1. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
2. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Test and start-up all equipment supplied under this contract.

1. Provide all reports necessary to assure the Engineer and Owner that all functions of each piece of equipment have been thoroughly evaluated and deemed operable as designed.
2. Ensure recorded data represents actual measured or observed conditions.
3. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
4. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
5. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
6. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

3.2 WATER SYSTEM PROCEDURE

A. Adjust water systems after air balancing to provide design quantities:

1. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
2. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
3. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
4. Effect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
5. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.3 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers to check leakage.

J. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches w.c. (12.5 Pa) positive static pressure near the building entries.

K. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

L. Ventilation: Contractor shall guarantee complete uniform circulation of air through ventilated spaces without objectionable noise. Contractor shall assume responsibility for and shall replace any faulty workmanship, material or equipment during a period of 1 year from date of final acceptance.

3.4 START-UP AND COMMISSIONING

A. Following substantial completion, contractor shall return to the site on a quarterly basis including four (4) balancing/commissioning sessions. Commissioning shall consist of rebalancing both air and water side systems to the extent required to verify proper operation of all system components and controls. Balancing contractor shall coordinate with all trades including controls contractor to make required adjustments.

END OF SECTION 23 05 00

SECTION 23 05 29
SUPPORTS AND ANCHORS

Part 1. – GENERAL

1.1 SUMMARY

A. Section Includes: Include labor, materials, equipment, and accessories to furnish and install supports, anchors, and seals for equipment, materials, and related work specified elsewhere.

1.2 SUBMITTALS

A. Submit shop drawings for all equipment provided under this section. Drawing shall include registered Structural Engineers Seal where required.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Guides manufactured by: Metraflex, Hyspan, Flexweld- Keflex, Flexicraft, Flexonic, Anvil International.

B. Supports and hangers manufactured by: B-Line, Grinnell, Michigan, Anvil International, NIBCO, National, Empire Industries and L.C. Penner.

C. Expansion anchors manufactured by: Hilti, Simpson, Illinois Tool Works.

D. Power driven fasteners manufactured by: Hilti, Simpson, Norbord.

E. Firestop material for penetration or construction manufactured by: 3M MP-1 Moldable Putty Flamseal Putty, 3M Caulk CP-25WB, Dow Corning 3-6548 RTV Foam, Tremco.

2.2 DUCTWORK INSERTS AND HANGERS

A. General: Support ductwork by concrete inserts in concrete construction, "C" clamps for beams and bar joists, or toggle bolts on prefabricated reinforced hollow concrete slabs. All supports shall be installed per SMACNA Duct Construction Standards latest addition.

B. Rectangular Ductwork: From any of these structure connection supports, provide hanger straps or hanger rod with supporting angle iron below rectangular ductwork:

Longest Dimension of Duct (Inches)	Rod Hangers	Strap Hangers	Trapeze Hanger or Shelf Angles	Spacing Max.
Up Through 18	3/8-Inch Rod	1 Inch by 18 Gauge	1 by 1 by 1/8	10 Feet
19 Through 30	3/8-Inch Rod	1 Inch by 18 Gauge	1 by 1 by 1/8	10 Feet
31 Through 42	3/8-Inch Rod	1 Inch by 16 Gauge	1½ by 1½ by 1/8	10 Feet
43 Through 60	1/2-Inch Rod	1 ½ Inch by 16 Gauge	1½ by 1½ by 1/8	10 Feet

61 Through 84	1/2-Inch Rod	1 ½ Inch by 16 Gauge	2 by 2 by 3/16	10 Feet

C. Round Ductwork: Form any of these structure connection supports, provide hanger straps or hanger rod with supporting angle iron below round ductwork:

Duct Diameter	Rod Hangers	Strap Hangers	Maximum Spacing
Up Through 18	1/4-Inch Rod	1 Inch by 22 Gauge	12 Feet
19 Through 36	3/8-Inch Rod	1 Inch by 20 Gauge	12 Feet
37 Through 50	2 - 3/8-Inch Rod	2 -1 Inch by 20 Gauge	12 Feet

D. Support:

1. Provide bridging between structural members to provide adequate support locations for hangers.

2.3 PIPING INSERTS AND HANGERS

A. Hanger Supports and Inserts: Piping suspended from construction above shall be hung from concrete inserts in concrete construction, toggle bolts and rod coupling on prefabricated, reinforced hollow concrete slabs, I-beam clamps or hanger rod, washer and two nuts on bar joist construction. On other types of building construction a field approved type clamp or bracket shall be used.

B. Hangers, Clamps, and Collars: Piping shall be suspended from inserts, clamps or brackets by means of clevis type or roller type hanger and solid steel rods spaced not more than 10 feet apart on steel pipe and pipe rings spaced not more than 8 feet apart on copper pipe. Support vertical cast iron and steel pipes at each floor by heavy wrought steel riser clamps or collars. Support vertical copper pipes at each floor by riser clamps with asphalt felt lining under couplings placed in vertical copper piping. Support piping 4-inches and larger by single pipe roller assemblies with adjustable socket.

2.4 ANCHORS AND GUIDES

A. Anchor Fabrication: Construct anchors using I-beams, channel iron, tees, or angles or a combination thereof.

1. Tee iron shall be welded to side, top or bottom of pipe. Angle iron diagonal bracing shall be welded or bolted to tee iron and wall or ceiling. Anchors shall be welded or double clamped to pipe.
2. Where a group of pipes are to be anchored, but cannot be secured as above, the pipes shall be anchored to an assembly constructed of I-beams, channels or both, which shall be anchored to the building structure.

B. Guides: Guides shall be fabricated from carbon steel. Housing shall be of two piece design, connecting upper and lower housing with two bolt or by welding, after spider and pipe have been set in lower half of housing. Lower housing shall have two legs for support running the full length of housing. Two piece spider clamp shall be fastened around pipe (or pipe with insulation) with two bolts forming six legs which guide pipe inside housing. Legs may be on bottom, side or top of unit for bolting to floor or top of beam, wall or underside of structure.

1. Insulation inside the spider clamp shall be hydrous calcium chloride with vapor barrier from entering and exiting pipe continuing through the clamp.
2. Unit shall be furnished with a factory baked enamel finish.

C. For multi-level wood floor construction allow for wood shrinkage and movement. Provide clearance for piping near wood construction.

PART 3. - EXECUTION

3.1 HANGER INSTALLATION

A. Hanger Location: Locate hangers to properly support pipes and ducts; relieve strain on pipe, duct, and fittings; and allow for ample expansion and contraction. Piping smaller than 4-inch size shall be hung with individual ring hangers where space prevents use of other type hangers.

1. Piping or ductwork shall not be hung from the roof deck.
2. Except where trapeze hangers are used to support piping, all piping and ductwork shall be individually supported. Do not support ducts or pipes from other pipes, ducts or equipment or conduit.
3. Place a hanger within one foot of each horizontal elbow.

B. Anchor Piping in Chases: Copper piping in pipe chases behind plumbing fixtures shall be anchored to waste and vent piping with angle iron and U-clamps with asphalt felt lining under clamps.

C. Trapeze Hangers: Groups of pipes at the same elevation and close together may, at the option of the Contractor, be supported by suitable trapeze hangers suspended from inserts, clamps or brackets by solid steel rods.

D. Plastic Piping Support: Support plastic piping from above inserts, clamps or brackets with Grinnell Figure 269 adjustable ring hanger on 32-inch centers.

3.2 PIPE HANGERS AND SUPPORT

A. Support horizontal steel and copper piping with maximum spacing between supports as noted.

Nominal Pipe Size (In.)	Distance Between Supports (Ft.)	Hanger Rod Diameter (In.)
½ & ¾	6	3/8
1 to 1 ½	8	3/8
2 & 2 ½	10	½
3 & 4	12	5/8
5 to 12	14	7/8

B. PVC Pipe shall have a maximum hanger spacing of every four feet for all sizes.

C. CPVC pipe or tubing shall have a maximum hanger spacing of every three feet for one inch and smaller and every four feet for sizes 1-1/4 inch and larger.

D. Provide additional supports for valves or other concentrated loads between supports.

E. Install hangers to provide minimum ½ inch clear space between finished pipe insulation and adjacent work.

F. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Provide hanger spreaders on hangers for pipes 4 inches and larger.

3.3 BRACKETS, BRACES AND SUPPORTS

A. General Requirements: Furnish and install brackets, braces or reinforcing angles in partitions not sufficient in themselves to support piping or plumbing fixtures or other wall hung equipment included in this Specification. Bolts shall extend through walls, finished on opposite side, or one wall of a pipe chase, and shall be not less than 3/8-inch brass bolts with 3-inch cut washer on opposite side of wall.

B. Fasteners: Bolt head and washer shall be concealed under wall finish on finished walls. On hollow walls not finished on opposite sides, use toggle bolts. On solid walls use 3/8-inch brass bolt extending 4 inches into wall secured with molten lead poured around bolt. Secure floor mounted wall closets with 5/16-inch brass bolt with chrome plated cap, nut, and washer.

C. Support Racks: Support tunnel piping on Unistrut, Bee-Line, pipe racks assembled as indicated by details on Drawings. Unistrut steel products shall have prime bonderized finish coating.

D. Pipe Drop Supports: Brace exposed pipe drops to pumps and other equipment with angle iron framework to relieve strain on flexible connectors or equipment and anchor piping to eliminate movement.

3.4 ANCHORS AND GUIDES INSTALLATION

A. Anchors: Install anchors approximately centered in every 70-foot run, blind ends, changes in pipe direction, except when elbow is used to absorb expansion and at major branch connections.

1. An expansion joint or loop or expansion elbow, but not more than one, with appropriate guides, shall be installed between each pair of anchors.
2. If expansion loops are installed in same line with expansion joints, the section containing the loop shall be isolated from the section containing the joint by means of an anchor.

B. Guides: Install 4 guides, 2 on each side, for each expansion loop or joint. On each side, install one pipe guide a maximum of 4 pipe diameters from expansion loop or joint and one pipe guide a maximum of 14 diameters from the first guide.

C. Anchors and Guides in Radiation Covers: Provide anchors and guides in radiation covers where called for on Drawings and specified. Provide guides at each side of expansion joints.

3.5 INSULATION PROTECTION AT PIPE HANGERS

A. Shield insulation shall be galvanized steel, 16 gauge for piping smaller than 4 inches, 14 gauge for piping 4 inches and larger and shall span an arc of 180 degrees. Lengths of shields shall be as follows:

Pipe Size	Shield Length
Up to 6”	12”
8”-12”	16”
Over 12”	20”

B. On cold and chilled water piping install a wood block at hanger points. Insulation jacketing shall be sealed where cut to install the block.

END OF SECTION 23 05 29

SECTION 23 05 45
SEISMIC ANCHORAGE AND BRACING

Part 1. - GENERAL

1.1 WORK INCLUDED

A. Provide pre-approved seismic bracing and anchorage for all piping systems, ductwork and equipment included in this division.

B. All equipment manufacturers shall submit letter of certification that equipment furnished is designed to maintain unit integrity while withstanding horizontal forces evaluated using appropriate “cp” factor in any direction and appropriate “Z” factor for the seismic region.

C. Refer to Seismic Appendix to Section 01300 for additional requirements.

D. Provide pre-approved all-directional seismic snubbers for lateral restraint of all spring-isolated equipment.

E. All pipes, ducts and conduits crossing a seismic expansion joint must have flexible connectors crossing the joint. Predicted movement at these locations can be a maximum of 3 inches vertically, horizontally, and laterally. See plans for location of seismic expansion joints.

1.2 SUBMITTALS

A. Submit product data for approval in accordance with Section 01300.

1.3 QUALITY ASSURANCE

A. Furnish pre-approved seismic anchorage devices.

B. Manufacturer’s representative to instruct Installer improper installation procedures.

C. Compliance with NEHRP Recommended Provisions for the Department of Seismic Regulation for New Buildings.

Part 2. – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Mason Industries, Inc. Hollis, NY-M.I.I.

B. B-Line Systems, Inc.

C. Metraflex Company.

2.2 DUCTWORK BRACING

A. Provide side and center bracing of all ductwork in accordance with local seismic code requirements, SMACNA bracing details, seismic duct details shown on drawings and structural drawings.

B. Refer to SMACNA Seismic Manual for size of bracing, bolt sizes and structural connections.

C. Refer to Part 3.2 Ductwork for additional requirements.

2.3 PIPE BRACING

A. Provide side and center bracing of all piping in accordance with local seismic code requirements, SMACNA bracing details and the structural drawings.

B. Bracing details, schedule and notes are to be used with the following types of pipes: Steel pipe schedule 40 and 80, copper pipe Type K, L, & M (only silver soldered brazed joints shall be used with copper pipe).

C. Provide flexible braid and hose connections at piping services entering the building such as: Gas piping, domestic water, fire line, etc.

2.4 SEISMIC RESTRAINT ASSEMBLIES

A. Furnish the following pre-approved devices designed to resist vertical loading simultaneously with seismic loading (transverse & longitudinal).

B. Standard Clevis Hangers: B-Line Figure B3100.

C. Adjustable "J' Hangers: B-Line Figure B3690.

D. Double Bolt Clamp Hangers: B-Line Figure B3144 Series.

E. Adjustable Steel Yoke Pipe Roll: B-Line Figure B3110 Series.

F. Pipe Strap: B-Line Figures B2400 Series.

G. Series Pipe Clamp: B-Line Figure B3140 Series.

H. Single pipe, clevis hanger transverse bracing: B-Line B3100 w/ATR rod, rod stiffener, B335 adjustable hinge & B22 channel, Figure 1.

I. Single pipe, "J" hanger transverse bracing: B-Line B3690 w/ATR rod, B335 adjustable hinge & B22 channel, Figure 2.

J. Single pipe, pipe clamp transverse bracing: B-Line B3144 w/ATR rod, B335 adjustable hinge & B22 channel, Figure 3.

K. Single pipe, pipe roller transverse bracing: B-Line B3110w/ATR rod, rod stiffener, B335 adjustable hinge & B22 channel, Figure 4.

L. Single pipe, transverse bracing: B-Line B2400 Series pipe strap 2/B22 channel, Figure 5.

M. Single pipe, longitudinal bracing: B-Line B3140 Series pipe clamp w/B22 channel, Figure 6.

N. Supported Multi-pipe transverse and longitudinal bracing: B-Line B2400 Series pipe straps w/B22 channels, ATR and B335 adjustable hinges, Figure 7.

O. Suspended Multi-pipe transverse and longitudinal bracing: B-Line B2400 Series pipe straps w/B22 channels, ATR and B335 adjustable hinges, Figure 8.

P. Concrete attachments (single point): Expansion or cast-in place anchors with B335 hinges attaching B22 channel, Detail 1.

Q. Concrete attachments (multi-point): Expansion or cast-in place anchors mounting B22 channel to B335 adjustable hinges and attaching to B22 channel, Detail 2.

R. Wood Beam attachment (perpendicular): Bolt and flat washer mounting B335 adjustable hinges attaching B22 channel, Detail 3.

S. Wood Beam attachment (parallel): 4" x 3" x 3/8" steel angle mounted with bolts and flat washer to B335 adjustable hinges attaching B22 channel, Detail 4.

T. Welded attachment to I-Beam: B3080S-1/2 welding lug attaching B335 adjustable hinge to B22 channel.

U. Channel Attachment: Concrete insert, B634 brace attaching B22 channel.

V. Standard Clevis Hangers: B-Line Figure B3100.

W. Adjustable "J" Hangers: B-Line Figure B3690.

X. Double Bolt Clamp Hangers: B-Line Figure B3144 Series.

Y. Adjustable Steel Yoke Pipe Roll: B-Line B3100 Series.

Z. Pipe Strap: B-Line Figure B2400 Series.

AA. Series Pipe Clamp: B-line Figure B3140 Series.

BB. Beam Clamp: B-Line Figures B3050.

CC. Adjustable Beam Clamp: B-Line Figure B3040.

DD. Top Beam Clamp: B-Line Figure B3042.

EE. Malleable Iron beam Clamp: B-Line Figure B3054.

FF. Side Beam Clamp: B-Line Figure B3045.

GG. Angle Iron Beam Clamp: B-Line Figure B3046.

HH. Retaining Strap: B-Line Figure B3362 thru B3365.

2.5 FLEXIBLE EXPANSION LOOPS

A. Where piping services cross building expansion joints, provide flexible pipe expansion loops.

B. Design loops to impart no thrust loads on anchors.

C. Loops shall consist of two flexible sections of hose and braid, two 90 degree elbows and a 180 degree return.

D. Install loops in a neutral, precompressed or preextended condition for application.

E. Install all guides, adjacent piping and supports in accordance with seismic code.

F. Select hoses for proper temperature and pressure ratings required by service.

G. Provide Model MLT stainless steel hose and braid loops with threaded or welded end fittings as follows:

1. Sizes ½-in thru 2-in with maximum 3-inch movement and rated for 455 psi at 70 degree F.
2. Furnish for the following services: Hot water heating, fire sprinkler and other steel piping systems.

H. Provide Model MLF stainless steel hose and braid loops with 150# flanged or welded or grooved ends as follows:

1. Sizes: 2-in thru 12-in with maximum 3-inch movement and rated for 125 psi at 70 degree F.
2. Furnish for the following services, Hot water heating, fire sprinkler and other steel piping systems.

I. Provide Model MLS bronze hose and braid loops with copper ends as follows:

1. Sizes: ¾-in thru 3-in with maximum 3-inch movement and rated for 125 psi at 70 degree F.
2. Furnish for the following services: Hot water heating, domestic cold water, domestic hot water, domestic hot water recirculation lines, and other copper piping systems.

2.6 NATURAL GAS SEISMIC SHUTOFF VALVES

A. Provide approved seismic shutoff valves and sensors to completely and automatically seal off gas supply under earthquake conditions.

B. Construct body of type 6061 bar stock aluminum to T6 condition milled on a CNC machine suitable for operating pressures up to 60 psi.

C. Components consisting of three (3) 440 type stainless steel cylindrical balls, one stainless steel roll pin, one 440 type stainless steel reset shaft, four O-rings, one glass site eye leveler, reset key, pressure gauge.

D. Construct valves for 0.50 to 60 psi service.

E. Device shall be UL listed, FM approved and certified by the State of California.

F. Furnish and install the Quakermaster Gas Shutoff valve system manufactured by Quake Master with lifetime warranty. Installing contractor must be certified and trained by Quake Master.

2.7 EQUIPMENT ANCHORAGE

A. Each equipment manufacturer must certify that equipment furnished is designed to maintain unit integrity while withstanding horizontal forces evaluated using appropriate “cp” factor in any direction and appropriate “Z” factor for the seismic region.

B. Floor or pad mounted equipment without vibration isolators shall be bolted to the floor with 3/8” expansion bolts, imbedded in concrete a minimum of 3 inches. Provide at four corners of equipment and on 4’-0” centers maximum unless otherwise noted.

C. Floor mounted equipment with vibration isolators shall be provided with lateral and vertical restraining devices (snubbers) on all sides of the base to restrict displacement of the equipment.

D. All-Directional Seismic Snubbers:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in this section of the specifications unless equipment manufacturer certifies direct attachment capability.
2. Provide a minimum of four (4) all-directional seismic snubbers for each spring-mounted base.
3. Provide double acting snubbers installed as close to the vibration isolators as possible to facilitate attachment to the base and the structure.

4. Snubbers to consist of interlocking steel members restrained by shock absorbent rubber materials compounded to Bridge Bearing Specifications.
5. Provide replaceable elastomeric materials, minimum of ¾ inch thick.
6. Provide a minimum 1/8-inch air gap in snubber design in all directions prior to contact between the rigid and resilient surfaces.
7. Install with factory set clearances.
8. All snubbers shall be independently tested and certified.
9. Select each particular seismic snubbers based upon a complete dynamic response analysis furnished by the vendor and based upon the seismic response data.
10. Furnish computer report including the following information along with the X, Y and Z axis.

    a. Six natural frequencies of the system with and without snubbing.
    b. Most probable movements (RMS values) at each mounting or combination mountings and snubbers locations as well as remote source points such as ducts, pipe and electrical connections and the machine extremities.
    c. Maximum accelerations at center of each significant system element.
    d. Most probable force (RMS value) at each mounting or combination mountings and snubber locations, all expressed in g units.
    e. Acceleration shall not exceed 4 g nor the excursion from center, 5/8-inch at the snubbers.

11. Snubber system shall be Mason Industries, Inc. series Z-1011 and all reports based on the computer program described above.
12. Furnish for the following equipment:

    a. Hot water pumps.
    b. Air Handling Units.
    c. All other vibrating equipment requiring vibration isolation which cannot be rigidly anchored.

Part 3. - EXECUTION

3.1 INSTALLATION

A. Install a restraint in accordance with Latest Edition of SMACNA's "Guidelines for Seismic Restraints of Mechanical Systems".

B. Refer to seismic tables in SMACNA Seismic Manual for size of bracing, bolt sizes and structural connections.

C. Attachment to structural members shall use devices included in Federal Specification WW-H-171 (MSS SP-69) or be welded as approved by the Structural Engineer.

3.2 DUCTWORK

A. Provide side and center bracing of all ductwork in accordance with local seismic code requirements and SMACNA bracing details.

B. No bracing is required if top of duct is suspended 12 inches or less from the supporting structural member.

C. Walks, including dry wall partitions, may replace required transverse or vertical bracing for ductwork.

D. Attachment to structural members shall use devices included in Federal Specification WW-H-171 (MSS SP-69) or be welded as approved by the Structural Engineer.

E. Braces shall be connected to the hangers/supports for ducts and not to the equipment itself.

F. All sheet metal for bracing to be Fy = 33 ksi. Minimum gauge for sheet metal for bracing to be as follows: 16 ga = 0.0598"; 14 ga = 0.0747"; 12 ga = 0.1046".

G. Brace all rectangular ducts of 6.0 square feet cross sectional area and larger.

H. Brace all round/oval ducts 28-inches in diameter and larger.

I. Transverse bracing to occur 30'-0" on center maximum. Transverse bracing shall be installed at each duct turn and at each end of duct run.

J. Longitudinal bracing shall occur at 60'-0" on center maximum. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it, if the bracing is installed within 4 feet of the intersection of both ducts and the bracing is sized for the larger duct.

K. No bracing is required if the top of duct is suspended 12-inches or less from the supporting structural member and attached to top of duct.

L. A group of ducts may be combined in a larger size frame using the overall dimensions with maximum weight for a selection of the members from the schedule.

M. Provide flexible duct connections where ductwork passes through building seismic or expansion joints, or where rigidly supported ductwork connects to equipment.

N. Refer to seismic tables in SMACNA Seismic Manual for size of bracing, bolt sizes and structural connections.

3.3 PIPING

A. Provide side and center bracing of all piping in accordance with local seismic code requirements, SMACNA bracing details and the structural drawings.

B. No bracing is required if top of pipe is suspended 12 inches or less from the supporting structural member.

C. Walls, including dry wall partitions, may replace required transverse or vertical bracing for piping.

D. Attachment to structural members shall use devices included in Federal Specification WW-H-171 (MSS SP-69) or be welded as approved by the Structural Engineer.

E. Braces shall be connected to the hangers/supports for piping and not to the equipment itself.

F. Brace all pipes 2-1/2 inches diameter and larger. In mechanical rooms also brace 1-1/4", 1-1/2" and 2" piping same as for 2-1/2" piping.

G. Provide transverse bracing at 40'-0" on center maximum.

H. Provide longitudinal bracing at 80'-0" on center maximum.

I. Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 25" of the elbow or tee and is of similar size.

J. Do NOT use branch lines to brace main lines.

K. Provide flexibility in joints (see flexible expansion loops) where pipes pass through building seismic or expansion joints, or where rigidly supported pipes connect to equipment with vibration isolators.

L. Support weight of vertical risers above center of gravity and at each floor slab penetration. Provide lateral guides at the top and bottom of riser.

M. Do NOT fasten on rigid piping system to the dissimilar parts of a building that may respond in a different mode during an earthquake: i.e. a wall and a roof.

N. Bracing details, schedule and notes are to be used with the following types of pipes: Steel pipe schedule 40 and 80, copper pipe Type K, L & M (Only silver soldered brazed joints shall be used with copper pipes).

O. For gas piping, the bracing details, may also be used except that transverse bracing shall be at 20'-0" on center maximum and longitudinal bracing at 40'-0" on center maximum. In addition, 1", 1-1/4", 1-1/2" and 2" pipes shall be braced the same as 2-1/2" pipe in schedule.

P. In boiler and mechanical rooms, bracing of all types of pipe shall be extended to include 1-1/4", 1-1/2" and 2" piping same as for 2-1/2" piping.

Q. No bracing is required if the top of pipe is suspended 12" or less from the support structural member.

R. Provide flexible braid and hose connections at piping services entering the building such as: Gas piping, fuel oil piping, domestic water, fire line, condenser water piping, etc.

3.4 EQUIPMENT

A. Floor or pad mounted equipment without vibration isolators shall be bolted to the floor with 3/8" expansion bolts, imbedded in concrete a minimum of 3 inches. Provide at four corners of equipment and on 4'-0" centers maximum unless otherwise noted.

B. Floor mounted equipment with vibration isolators shall be provided with lateral and vertical devices (snubbers) on all sides of the base to restrict displacement of the equipment.

END OF SECTION 23 05 45

SECTION 23 05 50
VIBRATION ISOLATORS

Part 1. - GENERAL

1.1 SUMMARY

A. Intent:

1. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolation materials shall be supplied by the same manufacturer.
3. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

B. The work in this section includes, but is not limited to the following:

1. Vibration isolation for piping, ductwork and equipment.
2. Equipment isolation bases.
3. Flexible piping connections.
4. Resilient Pipe Anchors and Guides.

1.2 SUBMITTAL DATA REQUIREMENTS

A. The manufacturer of vibration isolation shall provide submittals for products as follows:

1. Descriptive Data:

   a. Schedules of flexibly mounted equipment, referencing drawings by number.
   b. Catalog cuts or data sheets on vibration isolators.

2. Drawings:

   a. Submit details of equipment bases including dimensions, structural member sizes and support point locations.
   b. Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.
   c. Submit details of mountings for floor supported equipment, piping and ductwork.
   d. All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.
   e. Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.
   f. Complete flexible connector details.

Part 2. - PRODUCTS

2.1 INTENT

A. All vibration isolators described in this section shall be the product of a single manufacturer. Mason Industries products are the basis of these specifications; products of other manufacturers will be considered provided samples strictly comply with the specification and have the approval of the specifying engineer. Submittals and certification sheets shall be in accordance with Section 1.2.

B. Refer to Equipment Schedules on Drawings for specified isolator types in Section 2.2 that correspond to the

C. letters in that section.

2.2 PRODUCT DESCRIPTION

A. Neoprene mountings shall have a minimum static deflection of 0.35"(9mm). All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Mountings shall be type ND or rails type DNR as manufactured by Mason Industries, Inc.

B. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4"(6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF, as manufactured by Mason Industries, Inc.

C. Multiple bellow air springs shall be manufactured with powder coated upper and lower steel sections connected by a replaceable, flexible Nylon reinforced Neoprene element to achieve a maximum natural frequency of 3 Hz. (We have found 3 Hz adequate when using air springs. Should the specifying engineer require a lower frequency, change the 3 Hz to the lower number). Burst pressure must be a minimum of 3 times the published maximum operating pressure. All air spring systems shall be equipped with 3 leveling valves connected to the building control air or a supplementary air supply to maintain elevation plus or minus 1/8"(3mm). An air filter and water separator shall be installed before the air distribution system to the leveling valves.

Submittals shall include natural frequency, as well as load and damping tests, all as performed by an independent lab or acoustician. Air springs shall by type MT and leveling valves type LV as manufactured by Mason Industries, Inc.

D. Equipment with large variations in the operating and installed weight, such as chillers, boilers, etc., and equipment exposed to the wind such as cooling towers, roof mounted fans and roof mounted air handling equipment shall be mounted on spring mountings, as described in Engineering Specification B, including the neoprene acoustical pad within a rigid sided housing that includes vertical limit stops to prevent spring extension when weight is removed and temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed, without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 0.75"(20mm) larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 0.5"(12mm) to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation. Cooling tower mounts are to be located between the supporting steel and the roof or the grillage and dunnage as shown on the drawings when there is no provision for direct mounting. Housings and springs shall be powder coated and hardware electro-galvanized. Mountings shall be SLR as manufactured by Mason Industries, Inc.

E. Equipment with large variations in the operating and installed weight, such as chillers, boilers, etc., and equipment exposed to the wind such as cooling towers, roof mounted fans and roof mounted air handling equipment shall be mounted on air springs, as described in Engineering Specification C, but within a rigid sided housing that includes vertical limit stops to prevent spring extension when weight is removed and temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the air springs shall be pressurized to take the weight so the spacers can be removed without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as the horizontal modes. The hole through the bushing shall be a minimum of 0.75"(20mm) larger in diameter than the restraining bolt. Horizontal clearance between the air spring assembly and the housing shall be a minimum of 0.5"(12mm) to avoid bumping and interference with the air spring action. Vertical limit stops shall be out of contact during normal operation. Mountings and air spring parts shall be powder coated. Hardware electro-galvanized. Air spring systems shall be connected to the building control air or a supplementary air supply and equipped with three leveling valves to maintain level within plus or minus 0.125"(3mm). Cooling tower mounts are to be located between

the supporting steel and the roof or the grillage and dunnage as shown on the drawings when there is no provision for direct mounting. Mountings shall be SLR-MT and leveling valves type LV as manufactured by Mason Industries, Inc.

F. Hangers shall consist of rigid steel frames containing minimum 1-1/4"(32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification B seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.

G. Hangers shall be as described in F, but they shall be precompressed and locked at the rated deflection by means of a resilient upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.

H. Hangers shall be manufactured with minimum characteristics as in Specification B, but without the neoprene element. Springs are seated in a steel washer reinforced neoprene cup that has a neoprene bushing projecting through the bottom hole to prevent rod to hanger contact. Spring diameters and the lower hole sizes, shall be large enough to allow the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing.

If ducts are suspended by flat strap iron, the hanger assembly shall be modified by the manufacturer with an eye on top of the box and on the bottom of the spring hanger rod to allow for bolting to the hanger straps. Submittals on either of the above hangers shall include a scale drawing of the hanger showing the 30° capability. Hangers for rods shall be Type 30 or for straps W30 as manufactured by Mason Industries, Inc.

I. When total air thrust exceeds 10% of the isolated weight, floor mounted or suspended air handling equipment shall be protected against excessive displacement by the use of horizontal thrust restraints. The restraint shall consist of a modified Specification B spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4"(6mm) movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit. Horizontal thrust restraints shall be WB as manufactured by Mason Industries, Inc.

J. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14"(350mm) provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1"(25mm). Bases shall be type WF as manufactured by Mason Industries, Inc.

K. Vibration isolation manufacturer shall provide steel members welded to height saving brackets to cradle

equipment having legs or bases that do not require a complete supplementary base. Members shall have sufficient rigidity to prevent distortion of equipment. Inverted saddles shall be type ICS, as manufactured by Mason Industries, Inc.

L. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating concrete bases. Bases for split case pumps shall be large enough to provide support for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6"(150mm). The base depth need not exceed 12"(300mm) unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2"(12mm) bars welded in place on 6"(150mm) centers running both ways in a layer 1-1/2"(40mm) above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1"(25mm) clearance below the base. Wooden formed bases leaving a concrete rather then a steel finish are not acceptable. Base shall be type BMK or K as manufactured by Mason Industries, Inc.

M. Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top member shall overlap the bottom to provide water runoff independent of the seal. Aluminum members shall house electro-galvanized or powder coated springs selected for 0.75"(20mm) minimum deflection. Travel to solid shall be 1.5"(40mm) minimum. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4"(6mm) so as not to interfere with the spring action except in high winds. Manufacturer's self adhering closed cell sponge gasketing must be used both above and below the base and a flexible EPDM duct like connection shall seal the outside perimeter. Foam or other sliding or shear seals are unacceptable in lieu of the EPDM ductlike closure. Submittals shall include spring deflections, spring diameters, compressed spring height and solid spring height as well as seal and wind resistance details. Curb mounted bases shall be Type CMAB as manufactured by Mason Industries, Inc.

N. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal Z section containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4"(6mm) thick. Steel springs shall be laterally stable and rest on 1/4"(6mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous galvanized flexible counter flashing nailed over the lower curbs waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2"(50mm) of insulation. Curb shall be type RSC as manufactured by Mason Industries, Inc.

O. Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 1-1/2" through 14"(40mm through 350mm) shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" (400mm to 600mm) may be single sphere. Sizes 3/4" through 2"(20mm through 50mm) may have one sphere, bolted threaded flange assemblies and cable retention.

Minimum ratings through 14"(350mm) shall be 250psi at 170°F and 215psi at 250°F. (1.72MPa at 77°C and 1.48MPa at 121°C), 16"(400mm) through 24"(600mm) 180psi at 170°F and 150psi at 250°F. (1.24MPa at 77°C and 1.03 MPa at 121°C). Higher published rated connectors may be used where required.

Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.

The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 1/2"(12mm) thick Neoprene washer bushings large enough to take the thrust at 1000psi (0.7 kg/mm2) of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating

without them. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

P. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3"(75mm) and larger shall be flanged. Smaller sizes may have male nipples. Minimum lengths shall be as tabulated:

	Flanged	
3" x 14" (75 x 350mm)	6" x 20" (150 x 500mm)	12" x 28" (300 x 700mm)
4" x 15" (100 x 375mm)	8" x 22" (200 x 550mm)	14" x 30" (350 x 750mm)
5" x 19" (125 x 475mm)	10" x 26" (250 x 650mm)	16" x 32" (400 x 800mm)

	Male Nipples	
1/2" x 9" (12 x 225mm)	1-1/4" x 12" (32 x 300mm)	2" x 14" (50 x 350mm)
3/4" x 10" (19 x 250mm)	1-1/2"x 13" (38 x 325mm)	2-1/2" x 18" (64 x 450mm)
1" x 11" (25 x 275mm)		

At equipment, hoses shall be installed on the equipment side of the shut-off valves horizontal and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

Q. Split Seals consist of pipe halves with minimum 3/4"(20mm) thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 1"(25mm) past either face of the wall. Where temperatures exceed 240°F (115°C), 10 lb. density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.

R. All-directional acoustical pipe anchors consist of two sizes of steel tubing separated by a minimum 1/2"(12mm) thickness of 60 duro or softer neoprene. Vertical restraint shall be provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 500 psi(3.45 N/mm^2) and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.

S. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2"(12mm) thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of 1-5/8"(40mm) motion, or to meet location requirements. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.

T. The first four pipe hangers in the main lines near the mechanical equipment shall be as described in specification Type G. Hangers supporting piping 2"(50mm) and larger in all other locations throughout the building shall be isolated by hangers as described in specification F. Floor supported piping shall rest on isolators as described in specification D. Heat exchangers and expansion tanks are considered part of the piping run. The first four isolators from the isolated equipment shall have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first four hangers shall have 0.75"(20mm) deflection for pipe sizes up to and including 3"(75mm), 1-1/2"(40mm) deflection for pipe sizes over 3"(75mm) and up to and including 6"(150mm), and 2-1/2" (65mm) deflection thereafter. Where piping connects to mechanical equipment install specification O

expansion joints or specification P stainless hoses if O is not suitable for the service. All piping passing through the equipment walls, floors or ceilings shall be protected against sound leakage by means of an acoustical seal, as described in Specification Q.

U. All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design limits at the support points. Neutral central resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. The initial spring deflection shall be a minimum of 0.75"(20mm) or four times the thermal movement at the isolator location, whichever is greater. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions. Submittal must be stamped and signed by a licensed professional engineer in the employ of the vibration vendor for at least 5 years. Proper provision shall be made for seismic protection in seismic zones. The isolator manufacturer shall be the same firm supplying the mechanical contract. Support spring mountings shall be Specification B, anchors Specification R, telescoping guides Specification S.

V. The isolation vendor shall design and provide all brackets or clamps at riser spring guide and anchor locations. The contractor must install and adjust all isolators under the supervision of the isolator vendor or his representatives.

W. All air ducts with a cross section of $2ft^2(0.19m^2)$ or larger shall be isolated from the building structure by specification H hangers or B floor supports with a minimum deflection of 0.75"(20mm). Isolators shall continue for 50'(15m) from the equipment. If air velocity exceeds 1000 fpm (5.3mps), hangers or supports shall continue for an additional 50'(15m) or as shown on the drawings.

2.3 PUMPS AND MOTOR BASES

A. 5 Horsepower and Less: Mount pumps on floors above grade, 5 horsepower and less, grouted and bolted to a 4-inch concrete pad 4-inches larger in all directions than pump base and reinforced with three No. 4 rods running long dimensions. Pour concrete pad over pre-compressed molded fiberglass pads bonded to galvanized sheet metal and design for load and rpm as pump requires. Fiberglass pads shall be as manufactured by Consolidated Kinetics Corporation or shall be neoprene waffle mounts same as Mason Industries WMW.

B. Above 5 Horsepower: Mount pumps on floors above grade over 5 horsepower and provide with mason Industries, Type K, bases constructed of 6-inch channels with ½-inch reinforcing rods welded in place 6-inches on center both ways, 1 1/2-inch deflection anchored to floor and brackets. Pour frame solid with concrete and locate anchor bolts for pump in pour.

C. Units on Grade: Mount pumps located on grade on thickened concrete floor slab, top 4-inches above floor with ½-inch rubber expansion joint material between floor and perimeter of pump concrete pad. Pump assembly base shall have 5/8-inch thick by 3-inch wide neoprene waffle pad at all points of contract between pump base and concrete.

Part 3. - EXECUTION

3.1 GENERAL

A. The isolation vendor shall design and provide all brackets or clamps at riser spring guide and anchor locations. The contractor must install and adjust all isolators under the supervision of the isolator vendor or his representative.

B. All vibration isolators must be installed in strict accordance with the manufacturers written instructions and all certified submittal data. Remove space blocks and similar devices intended for any temporary protection against overloading during installation.

C. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. Building includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Coordinate work with other trades to avoid rigid contact with the building.

G. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

H. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.

I. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

I. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24"(600mm) or specified movements exceed 2.2-O capabilities.

J. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide 2.2-Q seals.

K. Locate isolation hangers as near to the overhead support structure as possible.

L. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight. Horizontal thrust restraints shall be 2.2-I restraints.

M. Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 100m/h(160 km/h) wind loads.

3.2 VIBRATION ISOLATION OF PIPING

A. Horizontal pipe shall be installed in accordance with 2.2-T Horizontal Pipe Isolation.

B. Risers shall be installed in accordance with 2.2-U Riser Isolation.

C. Spring Isolators:

1. Provide spring isolators on piping connected to isolated equipment as follows:

   a. 3- to 4-inch Diameter: First 3 points of support or 20 feet in both directions, whichever is greater.
   b. 5- to 8-inch Diameter: First 4 points of support or 50 feet in both directions, whichever is greater.
   c. 10-inch Diameter and Over: First 6 points of support or 50 feet in both directions, whichever is

greater.

2. Static deflection of first point shall be twice deflection of isolated equipment.

3.3 VIBRATION ISOLATION OF DUCTWORK

A. All duct runs shall be installed in accordance with 2.2-W Duct Isolation.

END OF SECTION 23 05 50

SECTION 23 07 00
INSULATION

Part 1. – GENERAL

1.1 SUMMARY

A. Field applied insulation for thermal efficiency and condensation control for hydronic piping, ductwork and equipment.

B. Definitions:

1. ASJ: All service jacket, white finish facing or jacket.
2. Air conditioned space: Space directly supplied with heated or cooled air.
3. Cold: Equipment, ductwork or piping handling media at design temperature of 60° F or below.
4. Concealed: Ductwork and piping above ceilings and in chases and pipe spaces.
5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas or exposed to outdoor weather.
6. FSK: Foil-scrim-kraft facing.
7. Hot: HVAC Ductwork handling air at design temperature above 60° F; HVAC and plumbing equipment or piping handling media above 105° F.
8. Density: Pcf - pounds per cubic foot.
9. Thermal conductance: Heat flow rate through materials.
10. Flat surface: BTU per hour per square foot.
11. Pipe or Cylinder: BTU per hour per linear foot.
12. Thermal Conductivity (k): BTU per inch thickness, per hour, per square foot, per degree F temperature difference.
13. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

Part 2. - PRODUCTS

2.1 SUMMARY

A. Materials:

1. All insulation shall have composite (insulation, jacket, and/or facing and adhesive used to adhere the facing or jacket to the insulation), fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 225 and U/LI 723 not exceeding Flame Spread 25 and Smoke Developed 50.
2. Jacket and Facing Descriptions:

    a. All purpose vapor barrier jackets.
    b. VB vapor barrier, white kraft bonded to 1 mil aluminum foil, reinforced with glass yarn. Water vapor permeability 0.02 perms.
    c. FSK reinforced foil and paper (Foil Scrim Kraft). Aluminum foil (minimum 0.75 mil thick) reinforced with fiberglass yard mesh and laminated to 40 lbs. chemically treated fire resistant Kraft UL rated.

3. Exterior Jacket:

    a. Venture Tape, Ventureclad 1557CW, (Alumaguard 60) 6 mil thickness, adhesive backed, aluminum finish jacket otherwise with zero permeability, shall be capable of being applied down to -20° F.

2.2 DUCTWORK

A. External rigid board insulation shall be Owens Corning 703 Series with FSK or ASJ (All Service Jacket) vapor barrier facing, 3 pound density fiberglass complete with non-combustible foil faced vapor barrier. Entire system shall be UL listed.

1. 0.030 thick PVC preformed jackets with seams made for welding.
2. 0.024 thick stucco embossed, smooth or corrugated pattern by Childers Products Company.

B. Internal Duct lining shall be Knauf Eclipse™ Air Duct Board is a resin-bonded fiber glass formed into rigid, rectangular boards faced on one side with a fire-resistant foil-scrim-kraft (FSK) vapor retarder and a lightweight black fiber glass mat on the airstream surface. Rigidity shall be EI-475. Thermal conductivity shall be 0.23 BTU in. per sq. ft. per °F. hour at mean temperature of 75°F. The airstream surface of duct board shall be is treated with an EPA registered, antimicrobial agent that prevents growth of mold, fungus or bacteria in accordance with ASTM C 1071, G21 and G22. Material shall be UL 181 listed and shall not exceed 25 Flame Spread, 50 Smoke Developed when tested in accordance with ASTM E 84, CAN/ULC S102-M88, NFPA 255, and UL 723.

C. Fiberglass blanket shall be 1 pound density, with factory applied type FSK jacket. Conductivity shall be 0.26 average maximum at mean temperature of 75°F.

2.3 PIPING

A. Piping shall be insulated with Manville (IMCOA, Owens-Corning, Knauf) "FLAME SAFE" fiber glass insulation. The insulation shall have an average thermal conductivity not exceeding 0.22 BTU in. per sq. ft. per °F. hour at mean temperature of 75°F.

B. Provide galvanized steel shields at all pipe hangers on insulated piping except hot water heating piping where pipes bear directly on the clevis. Shields shall be 16 gauge for pipes 4” and larger diameter and 20 gauge for smaller pipes.

C. Exposed areas inside a building shall be furnished with factory applied "FLAME SAFE" All-Purpose Vapor barrier jacket.

D. All piping in concealed areas inside a building shall be provided with factory applied "FLAME SAFE" VB (Vapor Barrier Jacket or All-Purpose Jacket).

E. All piping that is located outside and directly or indirectly exposed to the weather and is insulated, shall be totally enclosed and wrapped with a PVC pre-formed jacket.

F. Fittings, valve bodies and flanges for pipe size 4" and smaller shall be provided with PVC jackets over fiberglass inserts.

G. Armstrong (Rubatex, Halstead) Armaflex II flame retardant elastomeric thermal insulation, installed according to manufacturer’s recommendations and as allowed by Local Codes, shall be suitable for pipe temperatures between -40° and 220°.

Part 3. - EXECUTION

3.1 GENERAL

A. All piping and ductwork shall be thoroughly cleaned and dry prior to the application of insulation.

B. Furnish and install continuous and uncompromised insulation and jacket independent of sleeves, penetrations, supports and anywhere adjacent trade's work occurs.

C. Provide continuous vapor barrier over all seams.

3.2 DUCTWORK

A. Apply insulation in thickness and type as follows or per applicable state energy code, whichever is greater.

B. DUCTWORK OUTSIDE BUILDING EXPOSED TO WEATHER:

1. Externally insulate ductwork outside building exposed to weather with 2-inch thick, 3-pound density glass flexible glass fiberboard with an all purpose vapor barrier jacket.
2. Material: Insulation board shall have conductivity not to exceed 0.23 BTU per inch per square foot per hour at a mean temperature of 75° F.
3. Application: Apply insulation with edges butted and impaled over welded pins and secured with clips. Place pins to hold insulation securely in place, but not over 18 inches on center. Seal joints with 4-inch wide glass cloth vapor barrier type, permanently glued in place, and stapled.
4. Weather Protection: Cover insulation on all sides with 26 gauge galvanized steel. Seal all joints with an all weather duct sealant.

    a. Optional: Cover insulation on all sides with VentureTape, Venture Clad 1579 CW, aluminum color.

C. OUTSIDE AIR DUCTWORK: The outside air ductwork to ERV's, furnaces, and fan coils shall be insulated with 2" external foil faced rigid board fiberglass (or wrap for round duct) insulation or thermal resistance of R-8, whichever is greater (this includes the mixing box and/or sections of mixed air duct). 2" thickness glass fiber blanket may be used in lieu of board in concealed locations. Duct lining is not acceptable for outside air ductwork. Contractor shall coordinate the routing of all fresh air duct to maintain a minimum of 12" clearance from all domestic water and fire sprinkler piping.

D. COMBUSTION AIR DUCTWORK: The combustion air ductwork for boilers, laundry and all intake plenums shall be insulated with 1½" foil faced rigid board fiberglass insulation.

E. RETURN AIR DUCTWORK: Return air ducts shall be insulated with ¾" thickness internal glass fiberboard for all return ductwork within mechanical rooms.

F. MAKE-UP AIR SUPPLY DUCTWORK FOR UNCONDITIONED SPACES: Supply air ductwork located in an unconditioned cavity, mechanical or utility rooms shall be insulated for condensation control with 1½" thickness glass fiberboards. 1½" thickness glass fiber blanket may be used in lieu of board in concealed locations.

G. SUPPLY AIR DUCTWORK FOR DUCTED RETURNS: Supply air ducts shall be insulated with 1½" thickness glass fiberboards from air handling unit discharge up to runouts to each register/diffuser. 1½" thickness glass fiber blanket may be used in lieu of board in concealed locations.

H. SUPPLY AIR DUCTWORK FOR UNCONDITIONED SPACES: Supply air ductwork located in an unconditioned cavity shall be insulated for condensation control with 1½" thickness glass fiberboards. 1½" thickness glass fiber blanket may be used in lieu of board in concealed locations.

I. RETURN AIR, DRYER AND EXHAUST AIR DUCTWORK: Ducts within 10 feet of exterior wall and roof penetrations shall be insulated with 1½" inch thickness glass fiberboards. 1½" thickness glass fiber blanket may be used in lieu of board in concealed locations.

J. All individual room exhaust run outs shall be insulated with 1" wrapped insulation. Sidewall duct penetrations within floor/ceiling assemblies shall be insulated with 2" fiberglass wrap and/or a thermal resistance of R-8, whichever is greater.

K. DUCTWORK IN ATTIC SPACES: All ductwork in attic shall be insulated with 2" foil faced rigid board or wrap fiberglass insulation or thermal resistance of R-8, whichever is greater.

L. KITCHEN EXHAUST DUCTWORK:

1. Route grease exhaust duct within rated sheetrock enclosure. Provide Code required clearances. Provide bolted and gasketed access panels on the side of the ducts of sufficient size to permit a thorough cleaning of the entire duct interior. Provide at every change in direction with maximum spacing of 10 ft. intervals.
2. Provide Morgan Thermal Ceramics Firemaster, 2 hour fire barrier duct wrap. Install per manufacturer's recommendations for Class I grease ductwork up to a rated shaft.

M. DRYER DUCTWORK LOCATED IN RATED FLOOR CEILING ASSEMBLY**:**

1. Provide Morgan Thermal Ceramics Firemaster, 1 hour fire rated duct wrap. Install per manufacturer's recommendations for dryer exhaust ductwork. System shall provide a minimum 1 hour F-Rating and 1 hour T-Rating per ASTM E814.

N. CARE CENTER RESIDENCE UNIT SUPPLY AIR DUCTWORK WITHIN SOFFITS: Supply air ducts shall be insulated with 1 ½" thickness glass fiberboards completely at supply discharge plenum and extended a minimum of five feet from air handling unit discharge. 1½" thickness glass fiber blanket may be used in lieu of board in concealed locations.

O. All dryer, exhaust and outside air ducts within a floor/ceiling or ceiling/roof assembly that cannot maintain 12" clearance from sprinkler piping shall be insulated with 2" fiberglass wrap insulation.

3.3 PIPING:

A. Heating Systems and Cooling Systems above 40°F and Under 200°F:

1. Apply fiberglass insulation to provide a K-value of 0.27. If the K-value of a product is less 0.22, then the thickness must be adjusted to have an equivalent R-value. Runout branches 2" in diameter and less (not exceed 12 feet length) to individual terminal units: 0.5".

B. Refrigerant suction piping shall be insulated with 1" Armaflex. All outside insulation shall be wrapped with Venture Tape 1507 black line set tape.

C. All piping within 15' of any exterior opening within the mechanical room shall be insulated with a minimum of 1" Fiberglass unless indicated otherwise in this specification section.

D. For piping exposed to outdoor air, see insulation thicknesses for specific piping types below. Increase insulation thickness listed by ½".

E. Plastic sealed combustion appliance vent piping shall be insulated in attic or cold spaces with 2" thick or R8 equivalent insulation or per manufacturers minimum recommended thickness, whichever is greater.

F. All service water heating piping in contact with high conductivity material, including concrete, must have 1" minimum insulation K-value of 0.27. Snow melting mains shall be covered with insulation below the level of the concrete slab including U-turns at the concrete slab expansion joint locations. **Note: Contractor to verify with Local Authorities if insulation is required under the concrete slab. If required, verify thickness and type.**

3.4 JACKETS

A. Foil and Paper Jackets: Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1 1/2" laps at longitudinal joints and 3-inch-wide butt strips at end joints.

1. Seal openings, punctures and breaks in vapor barrier jackets and exposed insulation with vapor barrier compound.
2. Install PVC fitting covers over insulated flanges, fittings and valves.

B. Exterior Exposed Insulation: Install continuous PVC jackets and seal all joints and seams with waterproof sealant.

C. Install the PVC jacket with 1” overlap at longitudinal and butt joints and seal with adhesive.

END OF SECTION 23 07 00

Part 1. – GENERAL

1.1 SUMMARY

A. Manufacturer shall have in town local representation and service of the equipment provided.

1.2 WARRANTY

A. Temperature Control: Contractor shall be responsible for defects which develop in any part of the system caused by faulty workmanship, material or equipment and shall replace any such faulty workmanship, material or equipment during a period of 1 year from date of substantial completion. Instruments shall be calibrated to sense, activate and display information specified.

Part 2. - PRODUCTS

2.1 GENERAL

A. Contractor shall provide a complete automatic temperature control system as specified. Contractor shall provide all 120/240 volt circuits to power all low voltage control devices or line voltage devices such as 120 volt damper motor etc. All wiring shall be provided by this contractor. Electrical Contractor shall provide all 120/240, 1 phase, line voltage, control devices and wiring such as line voltage thermostats, time clocks and switches unless specifically noted to be supplied by this contractor and installed by the Electrical Division or remotely controlled and monitored by a Building Automation system.

B. Acceptable Manufacturers: Honeywell, Johnson, Trane, Carrier, Alerton, Invensys, Delta, Opera.

C. Space Thermostats:

1. Thermostats shall be of one type for like systems.
2. Thermostats shall have lockout and upper/lower limit temperature setpoint capability.
3. Standalone heat/cool device thermostats shall be Emerson (White Rodgers) model 1F95EZ series capable of auto or manual heat/cool changeover. Thermostats shall have large easy to read digital display with push pad adjustment controls.
4. Common Spaces: Provide electronic programmable thermostats shall be Emerson (White Rodgers) model 1F95 series capable of auto or manual heat/cool changeover. Thermostats shall have digital readout with push pad adjustment controls.
5. Common space and residence unit thermostats: Honeywell vision PRO 8000.

Part 3. - EXECUTION

3.1 GENERAL

A. Coordinate exact location of control power transformers and control panels with the Architect/Engineer.

B. Thermostat located in public areas shall be provided with clear lockable covers unless noted otherwise.

C. Thermostats shall have 50°-90° F temperature scale.

D. Coordinate required mounting height of thermostats with Architect.

E. Provide sensors and support brackets constructed of stainless steel, copper, brass, cast zinc or glass. Covers shall be galvanized steel painted with manufacturer’s standard paint and color.

3.2 CONTROL SEQUENCES

A. Fan Coils: Provide a programmable thermostat with fan/off/auto switch and unoccupied/occupied settings. The space thermostat shall cycle the condensing unit to maintain setpoint. The fan shall run continuously during occupied periods.

B. Variable Refrigerant Flow Fan coil System (VRF):

1. Provide wiring and install VRF System (Variable Refrigerant Flow) remote controllers to control system.
2. Provide centralized controller furnished with VRF system and provide all required wiring.
   a. The Centralized Controller shall support operation superseding that of the remote controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. The Centralized Controller shall allow automatic and remote control to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). Automatic control shall include on/off, operation mode selection (cool, heat, auto, dry, and fan), temperature setting, fan speed setting, and airflow direction setting.
   b. Centralized control shall allow enable or disable operation of local remote controllers.
   c. Centralized Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, and permit/prohibit of remote controllers. ON/OFF, Run and stop operation for a single group (Each Group or Collective). Switches between Cool/Dry/Auto/Fan/Heat. Sets the temperature for a single group, 3 air flow speed settings: Hi/Mid/Low. Start/Stop and Enable/Disable can be set 3 times in one day. Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.
   d. Provide power supply 12VDC for the centralized controller and 24VDC voltage for the central control transmission.

3. Fan Coils:

   a. The space room controller shall control the following individual operations (one per living unit as well as public space fan coils): On/Off, Operation Mode (cool, heat, auto and fan), temperature set point, fan speed setting. The space room controller shall support timer settings of on/off/temperature up to 8 times in a day in minimum 1-minute increments. The space Controller shall support an Auto Off timer and shall be able to limit the set temperature range. The room temperature shall be sensed at the space controller.
   b. The fan shall run continuously.
   c. Air conditioning shall be locked out when any auxiliary heat is enabled. In “cool and “auto” position, system shall cycle the dx coil valve to maintain cooling setpoint. When switch is in “off” position the unit is disabled. When fan switch is in “on” position, the fan runs continuously. When fan switch is in “auto” – fan runs continuously in cooling and cycles in heating. Adjust speed at the space room controller and set in position as indicated in the equipment schedule.

4. Provide Ethernet communication wiring from Owner Ethernet to Central Controller(s) so that system is capable of remote central monitoring and control at staff operator PC workstation(s). Coordinate to obtain necessary static IP addresses from Owner’s server to facilitate Ethernet communication.

C. Exhaust fans: Refer to 2.1.A for control. For I2 facilities (Nursing Homes), Provide an interlock between exhaust fans and corresponding air handlers (RTU’s, MAU’s, or AHU’s) serving the same areas of the building.

D. Kitchen Grease Exhaust Ventilation: Provide temperature sensor at each grease hood collar. Signal from any sensor shall activate Grease fan and kitchen MUA unit.

E. Heat recovery ventilators (HRV's):

1. Fan shall run continuously (high speed during occupied periods and low speed during unoccupied periods).
2. A freezestat shall shut the AHU off, close the dampers and open the heating valve.
3. Interlock the dampers with fan operation.
4. Coordinate with the AHU vendor for all necessary wiring.
5. Provide a duct sensor for modulating the heating valve to maintain discharge air setpoint. Provide a space sensor that will cycle the condenser for cooling requirements and shall override the ductstat for modulating the heating valve for maintaining space temperature. The thermostat shall have unoccupied/occupied setpoints.

F. Pool Dehumidification System (DHU):

1. Exhaust fan shall run continuously. Exhaust fan on, motorized O.A. damper open. Exhaust fan off, motorized O.A. damper closed.
2. Fresh air motorized damper (normally closed) shall be interlocked with DHU.
3. Install any sensors furnished with pool dehumidification unit. Space temperature shall be maintained at 82 deg F (adj) and space humidity shall be maintained at 60% RH (adj).
4. Electric Duct Furnace (Pool System Auxiliary Heat): Field install discharge air sensor and wire auxiliary heat to DHU controller.

3.3 START-UP AND COMMISSIONING

A. Following substantial completion, this contractor shall return to the site on a quarterly basis including four (4) balancing/commissioning sessions. Commissioning shall consist of rebalancing both air and water side systems to the extent required to verify proper operation of all system components and controls. Temperature Control contractor shall coordinate with all trades including balancing contractor to make required adjustments.

END OF SECTION 23 09 00

SECTION 23 09 23
AUTOMATIC DDC TEMPERATURE
CONTROL

Part 1.-GENERAL

1.1 WORK INCLUDED

A. Furnish, install, program and test a complete, operational system of automatic electronic or digital controls for mechanical systems as described in the Contract Documents. Provide (whether specified or not) all materials, minor items and other products required to provide a complete, operational system.

B. It is acknowledged that there may be up to two Building Automation Systems; One for the VRF system and one for the non VRF equipment and components. Both systems shall have web-based, mobile device and computer workstation/laptop operator interfaces.

C. All VRF related sensors and controls will be furnished by the Manufacturer and installed by this contractor.

D. The Building automation system (BAS) shall be BACnet compatible as defined by the latest ANSI/ASHRAE Standard 135.

1.2 APPROVED MANUFACTURERS

A.

Schneider Electric/IA Series	Cylon/AAM or Distech	Alerton
Andover	Honeywell	Johnson Controls

B. Manufacturer shall have in town local representation and service of the equipment provided.

1.3 SHOP DRAWINGS SUBMITTALS

A. Submit temperature control shop drawings for the Engineer's approval before installing or fabricating of any portion of the system. Submittal shall include but not be limited to the following.

1. System Architecture including control diagrams, wiring diagrams, a network block diagram.
2. Operator and web-based workstation software as well as sample of graphics interface.
3. Component specification data for all hardware and systems.
4. Control sequence descriptions.
5. Points list.
6. Installation subcontractor(s).

B. Submit manufacturer's installation instructions for all sensors, valves, dampers and third-party or OEM products.

C. Include all the components of the entire control system in the logical control descriptions specified.

D. Provide damper shop drawings that show data such as arrangement, velocities and control curves for each valve. Also, indicate whether the vale is normally open or normally closed.

E. Provide valve shop drawings that show data such arrangement, velocities and control curves for each valve. Coordinate control valve selection with the coil manufacturer's data such as a result of these two

characteristics shall provide for linear control of coil/ valve combined performance. Also, indicate whether the valve is normally open or normally closed.

F. Provide sample wall space sensors and thermostat covers and any other items that shall be exposed in finished spaces for review and approval by Owner.

G. Upon completion of the work, submit a report to the Engineer recording the check-out of the entire automatic control and energy management system as specified at the end of this Section.

H. After the Work has been accepted, correct all shop drawings to show as-built condition, final setpoint and accepted sensor ranges. Provide the required number of copies of as-builts diagrams and maintenance manuals to the Owner after completion of the Project. See Section 15010 for submittal instructions.

Part 2. - PRODUCTS

2.1 SYSTEMS COMPONENTS

A. Building/Network Controllers:

1. Building and Network are synonymous terms and for the purposes of this Specification shall mean the same thing.
2. The Energy Management and Control System shall be comprised of one or more independent, standalone, microprocessor-based Building Controllers to manage the global strategies describe herein.
3. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked Building Controllers.
5. The operating system of the Building Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Communication:

    a. Each Building Controller shall support direct Ethernet or a communications card. The communications card shall be connected to the Building Controller by a PC-104 bus connection. The Building Controller shall be connected to the BACnet network using the ISO 8802-3 (Ethernet) Data Link/physical layer protocol.
    b. Each Building Controller with a communications card shall perform BACnet routing if connected to a network of Custom Application and Application Specific Controllers.
    c. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol P-T-P for connection to a hand-held workstation/and/or modem.
    d. The Building Controller secondary communication network shall support BACnet MS/TP.
    e. Building Controllers shall be fully peer to peer.

B. Web Browser Interface

1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User

Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs shall not be permitted.

4. The Web browser client shall support at a minimum, the following functions:

    a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

5. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
6. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

C. Controllers:

1. Each unit controller shall contain a stand alone, DDC controller. To achieve this stand-alone operation, the controller shall continue to operate normally, relying upon preprogrammed default setpoints any time its connection with the rest of the control system are severed. For default setpoints, use values that shall provide steady, reliable operation of the systems until communications can be restored. Include proposed default setting as part of the shop drawings.
2. Include all the necessary hardware and software with each DDC unit controlled to accomplish the Control Sequence specified for its mechanical equipment. The control programs and data base, including default setpoints and control algorithms, shall reside in the DDC controller on EEPROM or on some other memory form that is permanent and not dependent upon continuous power. Furthermore, the memory form for this data shall be programmable without the removal or replacement of hardware. The operating system and application software shall reside in the DDC controller on some form of ROM.
3. Provide priority password security system with security levels to limit access to adjustable setpoints.
4. All the AHU and/or ERV controllers shall be capable to communicate with remote operator workstation and share information with each other.

D. Software and Programming:

1. Provide compatibility and access to the DDC BAS system via Web/internet based program.
2. The Owner’s workstation, at a location designated by the Owner, shall be provided with the latest Windows operating system software upgrade available, shall be fully graphical and provide: Scheduling, trending, reporting, security, adjusting setpoints, monitoring, and alarming of any point in the system, Web server capability and remote communication capability.
3. Software and graphics shall be an extension of the DDC Building control panel firmware.
4. Provide overall floor plan(s) including green or red indicator for each zone indicating whether zone is within setpoint range. Show the following location of equipment, thermostats and ductwork location.

    a. ERVs
    b. KMUA
    c. Exhaust Fans
    d. Sump Pumps
    e. Outdoor Weather Station

5. Operator shall be able to display point values that show real time changes and shall be able to override points, change control parameters with mouse based CAD like operations
6. Software and operator interface shall be capable of the following trend-logs:

    a. Measured Values

b. Operating Cycles Status
c. Equipment Status
d. Setpoints
e. Alarms
f. Cycles: start/stops

2.2 TEMPERATURE SENSORS

A. General Requirements (All sensors):

1. Use galvanized or stainless steel flanges to support elements in ducts. Use stainless steel immersion wells for sensors mounted in pipes or other vessels containing liquid.
2. Unless specifically noted otherwise, the Temperature Control Contractor shall furnish, install and connect all temperature sensors. Connect each sensor to its power source and also connect each sensor to its controlled device. Field calibrate all sensors during the testing period of the Contract. This requirement applies regardless of any factory calibration routinely provided.

B. DDC Space Sensors:

1. Provide a wall mounted, DDC space temperature sensor with a cover to conceal and protect the sensing element, allowing user interface and feedback.
2. Provide LCD display, up and down touch pad temperature adjustment and occupancy mode override switch. The controller shall activate occupied mode for 120 minutes (adj.).
3. Communication port connected to entire network allowing operator to communicate with the entire network.
4. Unless noted otherwise, provide sensors with an accurate range of at lest 50°F to 90°F.
5. Use sensors with sensing elements that are interchangeable with accuracies with ±1°F at 70°F.

C. Provide Electronic (or electric) Space Thermostats:

1. Standalone heat/cool device thermostats shall be Aprilaire 8400 series capable of auto or manual heat/cool changeover. Thermostats shall have large easy to read digital display with push pad adjustment controls.
2. Common Spaces: Provide electronic programmable thermostats shall be Aprilaire 8400 series capable of auto or manual heat/cool changeover. Thermostats shall have digital readout with push pad adjustment controls.
3. Provide a wall mounted, 24 volts electronic room temperature sensor with a cover to conceal and protect the sensing element. Unless noted otherwise, provide sensors with an accurate range of at least 50°F to 90°F. Use sensors with sensing elements that are interchangeable with accuracies with ±1°F at 70°F.
4. Line voltage Thermostats: Provide a wall mounted Thermostat with Integral manual On/Off/Auto selector switch: single or two-pole.

D. Outside Air Temperature Sensors:

1. Provide electronic outside air temperature sensors with an accurate range encompassing -20°F to 120°F. Use sensors with sensing elements that are interchangeable with accuracies within ± 1°F accuracy at 70°F. Install outdoor temperature sensors as shown on the Drawings confirming that the installation is in an accessible location where measurements shall not be affected by local conditions such as solar radiation heat from the roof, exhaust from the building or mist from a cooling tower. Provide weatherproof protection for these sensors.

F. Duct temperature Sensors:

1. Provide an averaging, electronic duct air temperature sensor with a sensing element located to measure the temperature across the entire duct, coil or mixing box cross section. Provide multiple sensors for large areas where a single sensor element is not long enough to provide reliable sensing across the entire cross section. Provide complete sensors with duct mounting flanges. Unless noted otherwise, provide sensors with an accurate range of at least 40°F to 140°F. Use sensors with sensing elements that are interchangeable with accuracies with ±1°F at 70°F.

G. Freezestats:

1. Provide an electronic low limit temperature switch with an element located to ensure reliable freeze protection. Each sensor switch shall respond to the coldest section along the length of the sensing element. Provide multiple freezestats for large ducts or coils where a single sensor element is not long enough to provide reliable sensing across the entire cross section. Install the sensor switch housing and wiring connection outside the air stream. Provide freezestats with an accurate range of at least 30ºF to 50ºF. Use freezestats with sensing elements that are interchangeable with accuracies within ± 1ºF accuracy at 40ºF. Provide manual reset freezestats that cannot be reset until the measured temperature rises at least 10ºF above setpoint.

2.3 PRESSURE SENSORS

A. Provide differential pressure sensors rated to withstand at least 10 inches of water column differential pressure. Use sensors with accuracies within ± 0.1% of span. Provide each sensor with an adjustable span, repeatability of ± 0.3% of span and infinite resolution. Provide sensors that are temperature compensated to ± 0.033% or full scale for each degree, F.

B. Duct Differential Pressure Sensors:

1. Install differential air pressure sensors specifically designed for duct mounting so they shall measure duct pressures relative to the pressures within the spaces they serve. Do not install sensors to measure duct pressures relative to the ceiling plenum or the mechanical room. Unless noted otherwise, use sensors with an accurate measuring range of at least 0 to 5 inches of water column.
2. Make duct tappings with a pitot tube configuration shall be a Dwyer A-301 static pressure tip specifically built for duct mounting. Terminate space pressure taps behind standard sensor covers identical to those used on the Project for temperature sensors.

C. Space Pressurization Sensors: Setra 264. The space differential pressure sensor shall be for controlling building pressure relative to outdoor pressure. Unless noted otherwise, use sensors with an accurate measuring range of at least minus 0.1 to positive 0.1 inches of water column.

2.4 FLOW SWITCHES

A. Provide differential pressure switches that produce a binary output upon a loss of flow in a duct or pipe. Apply differential pressure switches to differential pressures in the middle 33% of their accurate sensing range. Use sensors rated to withstand the pressure ratings of the piping or ductwork to which they are connected. Also use sensors rated to withstand the differential pressure capabilities of the pump or fan systems connected to the piping or ductwork where they are installed. On switches installed on cold services such as chilled water or domestic water piping, provide a vapor tight switch enclosure to prevent condensation damage.

2.5 ACTUATORS

A. Size all actuators to operate their dampers or valves with sufficient reserve power for smooth modulating action or quick two-position action and with enough power to close dampers or valves against the forces generated by the mechanical systems. Wherever possible, locate damper actuators out of the air stream.

B. Where two or more actuators must be operated sequentially, sequence them by spring range. Examples of sequential operation include parallel valves or minimum position outside air dampers sections.

2.6 CONTROL VALVES

A. Unless noted otherwise, the Control Contractor shall size, select and supply all automatic valves. The Mechanical Contractor shall install them. Provide position indicators on all automatic valves and pilot positioners on sequenced automatic valves. Size throttling valves with enough pressure drop to provide good control response throughout the throttling range. Two-position valves shall be line sized. Select valves to fail safe in normally open or closed position for fire protection, freeze protection, temperature control and humidity control in ascending order of priority.

B. Select valves with the proper flow characteristics so the valve and the control hardware combined shall provide true modulating flow and stable operation without hunting or drift. Select each valve so its maximum, design flow pressure drop (with the valve wide open) does not exceed 3 PSIG.

C. Where indicated on plan or called for in sequences of operation, provide pressure independent control valves (PICV) equal to Victaulic TA series (Bell & Gossett, Belimo, Siemens, Danfoss, Armstrong, Flow Control-Delta P) Valve shall come complete with externally adjustable flowrate and measuring ports integral to the valve body. Control Valves shall be factory set not-to-exceed the terminal device scheduled design flow rate.

D. Do not use butterfly valves for automatic, modulating control.

2.7 AUTOMATIC DAMPERS

A. The Temperature Control Contractor shall size, select and supply all motorized dampers. The Mechanical Contractor shall install all dampers. Size throttling dampers with enough pressure drop to provide good control response throughout the throttling range. The Mechanical Contractor shall provide all duct transitions necessary to adapt the dampers furnished by the Temperature Control Contractor to the mechanical systems.

B. Furnish motorized dampers at all locations where automatic dampers are shown on the Drawings or indicated in the specification in accordance with 23 30 00 and 23 80 00. Provide electric damper actuators for all dampers.

C. For outside air and return air dampers used for air mixing, use parallel blade dampers arranged to direct the two air streams together. Arrange damper blades in this manner even when this arrangement required that they span the longer duct dimension.

D. For all modulating dampers other than those used for air mixing, use opposed blade dampers, not parallel blade dampers.

2.8 ELECTRIC WIRING

A. Unless noted otherwise, provide all electric wiring interconnecting the various components of the temperature control systems under this Section of the Specifications. Perform all wiring in conformance with the requirements outlined below, with code requirements or with Electrical Division of the Specifications, whichever requirement is most stringent. This includes both power and control wiring.

B. Power wiring from line voltage control devices (such as interlocks, electric thermostats and electric aquastats) to controlled devices (such as fans, pumps or heaters) shall be provided under Mechanical Division.

C. Do not install wiring underground or in a concrete pour.

D. Do not attach raceways directly to metal surfaces subject to vibration or noise.

2.9 INDOOR AIR QUALITY (CO2) SENSORS

A. Shall have the ability to provide demand ventilation indoor-air quality (IAQ) control length through the economizer with an indoor air quality sensor.

B. The IAQ sensor shall be available in duct mount, wall mount, and wall mount with LED display of CO2 in parts per million. The set point shall have adjustment capability.

Part 3.-EXECUTION

3.1 GENERAL

A. Verify the location of each thermostat and all other exposed control sensors with the Drawings and with the Architectural details before installation. Generally, locate thermostats and sensors 60 inches above the finished floor, but refer to the Architectural Drawings for thermostat and sensor locations in public spaces. ADA and/or accessibility requirements may require 48" mounting height. If there are any questions regarding installation, confirm the locations with the Architect, Engineer and the Owner. State and Local code shall take precedence.

B. Complete the Temperature Control and Energy Management Systems in a timely manner so that no delay of the Project or of the Owner's beneficial occupancy shall result from the scheduling or the performance of the Work under this Contract.

3.2 TEST AND START-UP

A. No mechanical work shall be accepted by the Engineer or the Owner until it has successfully completed all its temperature control system tests.

B. Perform tests that verify that each damper and valve opens and closes completely and that each controlled device responds appropriately to its signal. Field calibrate each sensor so that it measures actual conditions within the accuracies specified.

C. The Temperature Control Contractor shall test each Control Sequence and verify in writing to the Testing and Balancing Contractor that each sequence performs as specified. The Testing and Balancing Contractor shall then retest each Control Sequence to verify that it is performing as specified. The Balancing Contractor shall then identify any sequences that do not perform properly in a written report to the Engineer and the Temperature Control Contractor.

D. The temperature control contractor shall be present and participate in all major equipment manufacturer's start-up processes. All aspects of the integrated communications and controls shall be coordinated and addressed with knowledgeable technical representatives from both parties (Contractor and Manufacturer) in person.

3.3 OPERATOR INSTRUCTION AND TRAINING

A. As soon as the testing procedures listed above have verified acceptable performance of the temperature control and energy management systems, provide on-site operator instruction to the Owner's operating

personnel. Perform this operator instruction during normal working hours. Assign this training to a competent representative of the Temperature Control supplier who is familiar with the Project.

B. At a time agreed to by the Owner, give at least four hours of instruction to the Owner's designated operating personnel on the operation of all equipment and functions of the temperature control systems.

C. All training sessions shall be video recorded in DVD format. Provide the owner with three labeled DVD copies for the training.

D. In addition to the instructions and training, provide an Owner's manual prepared specifically for this Project. Submit one copy of this manual to the Engineer before scheduling the training session(s). Once the manual has been approved by the Engineer, prepare four copies of the approved Owner's manual and deliver them to the Owner's Chief Operating Engineer along with a written request that the training session(s) be scheduled. Provide ongoing, refresher training totaling four hours of instruction for a period of one year after final acceptance of the Work. Refer to Section 23 00 10 for Owner's Manual requirements.

E. Furnish the Owner with a schedule of the maintenance tasks necessary to keep the automatic temperature control and energy management system operating at peak performance. In this list of tasks, indicate a recommended frequency of each preventative maintenance task and also list the tools necessary to perform the task.

3.4 WARRANTY

A. Guarantee all components, parts and assemblies against defects in material and workmanship for a period of one year after acceptance.

B. Provide service (parts, labor, shipping and personnel transportation) at no additional cost to the Owner for the full warranty period. Under this warranty, replace any faulty parts discovered and repair of any damage caused by the failure of any component of the systems provided under this Contract. Also provide free software updates, if any occur during the warranty period.

3.5 QUARTERLY COMMISSIONING

A. In collaboration with the Mechanical Contractor and the Balancing Contractor, this contractor shall make themselves available for three-eight hour sessions of minor adjustment and reprogramming of sequences that may be necessary to commission and verify system operation and control. These commissioning sessions shall be held on a quarterly basis three additional times following substantial completion. The last eight hour session shall be coordinated to be within the one year warranty period.

B. Commissioning sessions shall be coordinated and scheduled with the Owner's maintenance staff present so this may act to double as Owner training.

3.6 CONTROLLERS

A. Provide a separate controller for each AHU, terminal box or HVAC system.

B. Building controllers and advanced application controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. No additional controller boards or point modules shall be required to implement use of these spare points.

3.7 DDC CONTROL SEQUENCES

3.8 ERV; MAKE-UP AIR UNIT WITH ENERGY RECOVERY

A. This is a packaged outdoor unit which contains an energy recovery wheel designed to heat, cool and dehumidify 100% outside air.

B. A programmable controller with ambient dewpoint sensor shall be factory mounted internal to the rooftop unit and shall include outputs for sequencing heating and controlling energy recovery wheel.

C. Energy Recovery:
1. Anytime the outdoor air temperature is greater than the return air temperature plus 2 deg, the enthalpy wheel will be enabled.
2. If the outdoor air temperature is less than the return air temperature and the discharge air temperature is greater than the discharge air setpoint, the wheel will be disabled, supply/exhaust air bypass dampers will open and the cooling circuit will be enabled to maintain setpoint.
3. If the outdoor air temperature is less than the return air temperature and the discharge air temperature is less than the discharge air setpoint, the enthalpy wheel will modulate from minimum speed to maximum speed to maintain the discharge air setpoint. Once the enthalpy wheel is at 100% and the discharge air temperature is still below setpoint, the heating valve will begin to modulate open.
4. If the exhaust air temperature drops below the minimum exhaust air temperatuere of 7 deg F (adj.), the enthalpy wheel speed will decrease to maintain exhaust air temperature. If the wheel is at its minimum speed and the exhaust air temperature is still below its minimum setpoint, the wheel shall be disabled.

D. Safeties:

1. Duct smoke detector, provided by Division 26, will stop the supply fan upon sensing an alarm.

E. The following functions shall be controlled at the workstation or operator interface:

1. ERV unit start/stop.

F. The following conditions shall be alarmed at the operator's terminal.

1. Discharge temperature out of limit (High/Low).
2. If discharge air temperature drops below 40° F, a freeze stat shall shutdown the MUA and send alarm signal.
3. Supply fan failure (sensed by DP switch).
4. Exhaust fan failure (sensed by DP switch).
5. Fire alarm single point alarm from fire alarm panel.

G. The following conditions shall be monitored:

1. Supply fan status, (current sensor or VFD)
2. Exhaust fan status, (current sensor or VFD)
3. Outside air temperature
4. Outside air relative humidity
5. Discharge supply air temperature
6. Supply duct system pressure
7. Exhaust duct system pressure
8. Filter proof, (DP switch on excessive pressure drop)- one per filter bank

H. ERV Unit Points List:

1. Supply fan start/stop (DO)
2. Supply fan status (DI)

3. Supply fan VFD speed (AO)
4. Exhaust fan start/stop (DO)
5. Exhaust fan status (DI)
6. Exhaust fan VFD speed (AO)
7. Filter pressure limit (DI)
8. Supply air temperature (AI)
9. Space relative humidity (AI)
10. Smoke detector (DI)
11. Supply static pressure alarm (DI)
12. Exhaust static pressure alarm (DI)
13. Enthalpy Wheel Status (DI)
14. Enthalpy Wheel S/S (DO)
15. Enthalpy Wheel Control (AO)

3.9 KITCHEN MAKE-UP AIR UNIT

A. This unit contains an intake motorized damper, electric heater and blower fan.

B. The Fan shall be interlocked with the kitchen grease exhaust fan and shall be monitored for failure.

C. Install and wire MUA control panel and discharge air control furnished with unit. Provide labeled wall switch for kitchen cook line exhaust hood operation, which, when in the on position, will open the MUA outdoor air damper. Once damper is proven open, both exhaust fan and MUA blower shall be on. When wall switch is in the off position all fans shall be off and intake damper shall be closed.

D. Safeties:

1. A software freezestat will stop the fan whenever the supply air temperature falls below 40°F for 20 seconds. Upon original fan startup this time delay will be 2 minutes. This time adjustment must be available and noted on WEB graphic.
2. Duct smoke detector will stop the supply fan upon sensing alarm.
3. Signal from hood fire alarm system shall shut down MUA blower. Exhaust fan shall continue to run.

E. Points:

1. MUA Status
2. MUA Alarm
3. Supply fan Status (DI)
4. Discharge air temperature (AI)

3.10 DUCTLESS SPLIT SYSTEM AIR CONDITIONER(S) (AC/CU)

A. Install programmable thermostat furnished with packaged cooling unit and air conditioner. Provide all required control wiring.

B. Provide unit status, alarm and space temperature to EMS.

3.11 VARIABLE REFRIGERATION FLOW FAN COIL SYSTEM (VRF)

A. Provide wiring and install VRF System (Variable Refrigerant Flow) remote controllers to control system.

B. Install centralized controller: G-50A Centralized Controller furnished with VRF system and provide all required wiring.

1. The Centralized Controller shall support operation superseding that of the remote controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

The G-50A Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the G-50A Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2-Series only), dry, and fan), temperature setting, fan speed setting, and airflow direction setting. Since the G-50A provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the G-50A Centralized Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, and permit/prohibit of remote controllers. ON/OFF, Run and stop operation for a single group (Each Group or Collective). Switches between Cool/Dry/Auto/Fan/Heat. Sets the temperature for a single group, 3 air flow speed settings: Hi/Mid/Low. Start/Stop and Enable/Disable can be set 3 times in one day. Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.

2. Power Supply (PAC-SC50KUA):The power supply shall supply 12VDC (TB 3) for the G-50 centralized controller and 24VDC (TB 2) voltage for the central control transmission.

C. VRF Fan Coils (heads):

a. The space room controller shall control the following individual operations (one per living unit as well as public space fan coils): On/Off, Operation Mode (cool, heat, auto and fan), temperature set point, fan speed setting. The space room controller shall support timer settings of on/off/temperature up to 8 times in a day in minimum 1-minute increments. The space Controller shall support an Auto Off timer and shall be able to limit the set temperature range. The room temperature shall be sensed at the space controller.

b. The fan shall run continuously.

c. Air conditioning shall be locked out when any auxiliary heat is enabled. In “cool and “auto” position, system shall cycle the dx coil valve to maintain cooling setpoint. When switch is in “off” position the unit is disabled. When fan switch is in “on” position, the fan runs continuously. When fan switch is in “auto” – fan runs continuously in cooling and cycles in heating. Adjust speed at the space room controller and set in position as indicated in the equipment schedule.

D. Provide Ethernet communication wiring from Owner Ethernet to Central Controller(s) so that system is capable of remote central monitoring and control at staff operator PC workstation(s) or mobile device. Coordinate to obtain necessary static IP addresses from Owner’s server to facilitate Ethernet communication.

3.12 MISCELLANEOUS POINTS

A. Outdoor Air Temperature

B. Outdoor Air Humidity

C. Building (Lobby) Space Pressure

D. Circulating hot water pump, CP-1, shall Cycle based on aquastat setpoint of 110 degrees, mounted at the recirculating hot water piping.

3.13 KITCHEN GREASE EXHAUST VENTILATION

A. Kitchen Grease Exhaust Ventilation: Provide temperature sensor at each grease hood collar. Signal from any sensor shall activate (sensor setpoint will make circuit when temperature exceeds 90°F (adj.)) Grease fan and kitchen MUA unit.

B. Points:

1. EF Status
2. EF Alarm

3.14 MISCELLANEOUS EXHAUST FANS

A. See Equipment Schedule.

3.15 MISCELLANEOUS EXHAUST FANS (EF)

A. Provide status and start/stop control and alarm for each exhaust fan displayed at EMS front end.

B. Kitchen Grease exhaust fan(s) shall have local control switch. See Kitchen MUA control sequence.

C. Dishwasher exhaust fans shall be interlocked with dishwasher operation. Provide 15 minute time delay (adj.) so fan continues to run after dishwasher cycle is complete.

3.16 DOMESTIC HOT WATER CIRCULATING PUMP(S)

C. Cycles from a 120 volt aquastat mounted at the recirc water piping. Provide aquastat and power wiring.

3.17 WATER SOFTENERS

A. Provide all wiring and other accessories. Coordinate with the water softener vendor for all necessary wiring.

3.18 SUMP PUMP

A. Provide all wiring and other accessories. Provide pump status and hi-limit alarm to EMS front end.

3.19 POOL DEHUMIDIFICATION UNIT

A. Install factory furnished control panel.

B. Wire electric duct coil to control panel auxiliary heat contacts.

C. Interlock pool exhaust fan and outside damper with dehumidification system supply fan.

D. Pool space exhaust fan shall run continuously. Provide Pool EF status and alarm to EMS system.

E. Provide space temperature and humidity inputs back to EMS system.

3.20 START-UP AND COMMISSIONING

A. Following substantial completion, this contractor shall return to the site on a quarterly basis including four (4) balancing/commissioning sessions. Commissioning shall consist of rebalancing both air and water side systems to the extent required to verify proper operation of all system components and controls. Temperature Control contractor shall coordinate with all trades including balancing contractor to make required adjustments.

END OF SECTION 23 09 23

SECTION 23 20 00
PIPING MATERIALS AND METHODS

Part 1. - GENERAL

1.1 SUMMARY

A. All piping materials and methods of construction and workmanship shall be provided as per the requirements of local codes and regulations.

1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
2. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

B. Lead pipe, solders, flux, etc., are not allowed. All piping and valves associated with the potable water system shall not exceed the 0.25% maximum lead content per U.S senate Bill No. S.3874 and NSF/ANSI 372.

C. The contractor is responsible for verifying all invert elevations with respect to building finished floor elevations and site provisions.

Part 2. - PRODUCTS

2.1 PIPING

A. Heating and Chilled Water Piping:

1. Type "L" hard drawn copper tubing ASTM B88-03 with wrought copper fittings, using 95/5 solder or brazing.
2. Type "L" seamless grooved copper tube with grooved copper couplings and fittings.

    a. Fittings shall be ASME B16.22 wrought copper or ASME B16.18 cast bronze, with copper-tube dimensioned grooved ends. Victaulic Copper-Connection, Grinnell Grove Copper System and Gruvlok CTS.
    b. Couplings shall be installation-ready, gasket rated to +250°F, and zinc electroplated steel bolts and nuts. Victaulic Style 607, Grinnell Style 640 and Gruvlok 6400 or 6402.
    c. System shall be manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)

3. Schedule 40 A-53 ERW black steel pipe with cast iron screwed, welded or grooved fittings.

    a. Rigid Type: Housings shall be cast to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

        1) 2” through 8”: Installation-Ready, stab installation without field disassembly, grade EHP gasket rated to +250°F / 120°C. Victaulic Style 107H, Grinnell Style 740 and Gruvlok 7402.
        2) Victaulic Zero-Flex Style 07, Grinnell Style 772 and Gruvlok 7400 or 7401.

    b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Installation-Ready Style 177 or Style 77 and Grinnell Style 707 and Gruvlok 7000 or 7001.
    c. 14” through 24”: Victaulic AGS series and Grinnell Style 772 and Gruvlok 7001-2 or 7011.

1) Rigid Type: Provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07, Grinnell Style 772 and Gruvlok 7001-2 or 7011.
2) Flexible Type: Allow for linear and angular pipe movement. Victaulic Style W77 and Grinnell Style 707 and Gruvlok 7000 and 7001.

4. Viega Pro-Press System and Grinnell Copper G-Press system may be used on type K, L and M hard copper tubing, sizes ½" to 4" and soft copper tubing in ½" to 1 ¼". System shall be approved for up to 200 psi operating pressure and 250ºF for joining copper tubing. Viega Pro-Press and Grinnell Copper G-Press shall only be used on piping system containing fluids and gases as indicated in the manufacturers approved listing. All application shall include the proper factory standard or field installed specialty seals.
5. Victaulic 304 stainless steel Pressfit system ½"-2" and Grinnell 316 stainless steel G-Press ½"– 4".
6. Schedule 80 PVC meeting or exceeding ASTM F441with approved solvent welded fittings meeting or exceeding ASTM 2457.
7. CPVC and Schedule 80 PVC piping shall be acceptable for use with glycol solution percentage by volume as specified.
   a. All valves, accessories, and appurtenances used with CPVC piping system shall have a metallic body with flanged or threaded connections.
   b. All threaded connections shall be made using manufacturers male adapter fittings with metallic threads. Fittings with plastic threads are not acceptable.

B. Condensate Drain Piping:

1. Type "M" seamless copper hard and soft temper ANSI-H23.1 with wrought copper fittings using 95/5 solder or brazing. Type "M" shall not be used on domestic hot water circulating systems.
2. PVC Schedule 40 unthreaded or PVC Schedule 80 threaded. Pipe and corresponding fittings installed per Code limitations.
3. CPVC Schedule 40 unthreaded or PVC Schedule 80 threaded. Provide plenum rated material if applicable. Pipe and corresponding fittings installed per Code limitations.

2.2 VALVES

A. Acceptable Valve Manufacturers:

1. Apollo, Titan FCI, Milwaukee, Victaulic, Nibco, Watts, Mueller, Hammond, Griswold, Anvil, Gruvlok, Grinnell.
2. All valves for potable water shall be low level lead 0.25 percent average lead content.

2.3 FLOW FITTINGS/BALANCE VALVE

A. Acceptable Manufactures:

1. Bell & Gossett, Nibco, Mueller, Victaulic/TA Hydronics, Anvil Gruvlok, Grinnell.

B. Bell & Gossett "Circuit Setter", Victaulic/TA Hydronics or Grinnell Circuit balancing valve. All bronze/brass ball or copper-alloy/ductile iron globe type construction with memory stop and integral valved read-out ports. Provide metal identification tags indicating location, size, GPM and meter reading.

2.4 MISCELLANEOUS VALVES:

A. Drain Valves-Heating and Chilled Water Piping:

1. Nibco #C56-VB, ¾" male thread, tee handle and vacuum breaker.

2. Apollo Series 78-100 or Milwaukee BA100H ball valve, 600 pound, bronze body, chrome plated brass ball and blow-out proof brass stem, reinforced Teflon seals and seats and ¾" hose thread outlet with cap.

Part 3. - EXECUTION

3.1 GENERAL

A. Provide offsets and transitions to hydronic and steam piping due to existing structure and trades work.

B. Slope water piping 1" per 40' and arrange to drain at all low points.

C. Provide shut-off valves to comply with Code and good installation practice for the proper isolation of equipment. All branch take offs shall have isolation shut off valves. Provide extended stem valves where insulated for proper valve operation. Except as otherwise specified or shown on plans, valves 2-1/2 inch and smaller shall have screwed end connections and valves 3 inch and larger shall have grooved end or flange end construction. Install manual drain valves at every low point of each water piping system.

D. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).

E. Provide escutcheon plates at all wall, floor, or ceiling piping penetrations. This includes all mechanical piping systems. Escutcheon plates shall match the finish of the surrounding area.

F. Provide a dielectric coupling or waterway fitting at all connections of dissimilar metals. Provide adequate clearance for insulation and for access to valves. All piping shall be concealed and shall maintain proper clearances for ceilings, ducts, walls, lighting, etc. except that piping may be exposed in mechanical areas. At all fixture and equipment connections where nipples are necessary between copper fixtures and tubing, such nipples shall be full size brass nipples with brass or copper adapters.

G. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.

H. Push-to-Connect Joints: Install Permalynx joints in accordance with the manufacturer's latest published installation instructions. Prepare and mark tubing ends using a tool supplied by the manufacturer and in accordance with the manufacturer's instructions.

I. Install Vic-Press 304™ in accordance with Victaulic recommendations. Pipe shall be certified for use with the Vic-Press 304™ system, square cut (+/-0.030"), properly deburred, and cleaned. Pipe ends shall be marked with a gauge supplied by Victaulic. Use a Victaulic 'PFT' series tool with the proper sized jaw for pressing.

J. Condensate Drains:

1. Provide a deep seal "P" trap at condensate drain beneath each water heater, and extend piping to nearest floor drain, service sink or as shown on drawings.
2. Effective water seal of "P" trap shall be minimum of two times negative static pressure in fan plenum for draw-through fan unit, but not less than 3 inch. Depth of trap shall be minimum of one-half the plenum maximum negative static pressure.

3. Traps for roof mounted equipment shall be constructed of rubber; drain piping shall be PVC, ABS plastic, or Type "M" copper with soldered joints.
4. When code allows and when routing condensate to local lavs, provide tailpiece for branch connection. Coordinate unit requiring tailpiece with HVAC Contractor.

END OF SECTION 23 20 00

SECTION 23 30 00
DUCTWORK MATERIALS
AND METHODS

Part 1. – GENERAL

1.1 SUMMARY

A. All above ground ductwork material and construction shall be galvanized steel, installed in accordance with the Standards described in the latest edition of the ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers) Guide and Data Book, SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) and Local governing mechanical codes.

B. Insulated ductwork may be factory manufactured pre-insulated duct and fittings, constructed in compliance with SMACNA Phenolic Duct Construction Standards.

C. Changes in direction, elevation or shape shall be made by gradual methods such as radiused elbows of diverging or converging reducing fittings. Changes in dimension shall not exceed 20° diverging angle. Elbow radii shall be the width of the duct in the plane of the bend.

Part 2. - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. Registers, Grilles and Diffusers and Terminal Air Devices: Titus, Price, J & J, Krueger, Tuttle and Bailey, Carnes, Nailor, Metalaire, Reliable Metal.

B. Pre-insulated Duct and Fittings: Ducts and Cleats, Thermaduct, AQC Industries.

C. Louvers: Cesco, Air Balance, Arrow United, Louvers & Dampers, Inc., Safe-Air, Pottorff, Greenheck.

D. Fire, Smoke, Combination Fire/Smoke, and Radiation Dampers: Prefco, Ruskin, Greenheck, Cesco, United Air, American Warming, Safe-Air, Nailor, Acme, Pottorff, Aire Technologies.

2.2 REGISTERS, GRILLES AND DIFFUSERS

A. Unless indicated, otherwise wall and ceiling R, G, D’s shall be white; floor registers shall have plain aluminum finish. Color finishes shall be approved by the Architect.

TYPE	TITUS MODEL NO.	DESCRIPTION
A	TMRA	Adjustable steel round diffuser. Provide D-75 opposed blade neck mounted damper, color white. Provide foam gasket when mounted to finished ceiling.
B	TMS[A]	Adjustable steel square diffuser for lay-in ceiling. ****Use neck damper only in non-accessible ceilings and non-noise critical applications.**** [Provide D-75 opposed blade neck mounted damper.]
C2		
C3		
C4		

D2		
D3		
D4		
E	300RL	Double deflection steel supply register. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
F	300FL	Double deflection aluminum supply register. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
G	301FS	Single deflection aluminum supply register. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
H	ML-38	Extruded aluminum linear slot diffuser, ¾" slot. Provide matching lined diffuser plenum model MP-38.
I	Price Model PDMC	Perforated ceiling diffuser, flush face, white finish. Provide type D-75 opposed blade neck mounted damper.
J	CT-581 (15°) or CT-580 (0°)	Extruded aluminum linear bar diffuser, 1/2" spacing, 1/8" bars. Provide opposed blade dampers for floor mounted applications.
K	CT-PP-3 (30°) or CT-PP-0 (0°)	Extruded aluminum linear bar diffuser (pencil proof), 7/16" spacing, 7/32" bars. Provide matching diffuser plenum model MP-38. Provide opposed blade dampers for floor mounted applications.
L	CT-480	Aluminum fixed linear bar. Provide type 1 border. Provide sheet rock frame in plaster ceilings. Provide opposed blade dampers for floor mounted applications.
M	PAR	Perforated ceiling steel return panel, for lay-in ceiling, white finish.
N	PXP	Perforated ceiling steel return panel for lay in ceiling, white finish.
O	Not used	
P	355RL	Steel return/exhaust register. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
Q	350RF2	Filtered steel return grille, 2" filter. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
R	33RL	Heavy duty steel return register. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
S	355FL	Aluminum return/exhaust register. Provide type 1 border. Provide plaster frame in sheet rock ceilings.

T	PCS	Perforated ceiling diffuser, flush face, white finish. Provide type D-75 opposed blade neck mounted damper.
U	355RL	Steel transfer grille. Provide type 1 border. Provide sheet rock frame in plaster ceilings.
V	355FL	Aluminum transfer grille. Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
W	TBDI-FR	Fire rated plenum slot diffuser, 2 way blow, 4 foot long, 3/4" slot, number of slots as indicated. Provide cross notch option when used in a 2 x 2 ceiling. Provide sheet rock frame option when used in sheet rock ceilings. Provide optional center T-bar. Provide lined plenum.
X	PAR-FR	Fire rated perforated steel return grille, 24" x 24". Provide type 1 border. Provide sheet rock frame in sheet rock ceilings.
Y	50R	Eggcrate steel return grille, for lay-in ceiling with ½" x ½" x ½" grid.
Z	MCD	Square ceiling diffuser, steel, 4 way adjustable, surface mount.
AA	250	Rectangular ceiling diffuser. Provide AG-15 galvanized steel opposed blade damper. Provide type 1 border. Provide plaster frame in plaster ceilings.

NOTE: SELECT ALL DIFFUSERS AND REGISTERS BELOW "NC" OF 30. NOT ALL DIFFUSERS ARE NECESSARILY USED. REFER TO PLANS.

2.3 DRYER/VENTS

A. Provide aluminum ductwork properly sealed and insulated. Provide gooseneck, relief hood or wall cap with backdraft damper. Insulate per discharge ducts in Section 23 07 00.

B. Provide aluminum roof vent caps and sidewall vent louvers for toilet and dryer exhausts with backdraft dampers. Provide bird screens for unit toilet exhausts only.

2.4 RELIEF/EXHAUST WALL AND ROOF VENTS

A. Wall Caps: Coordinate with Architect finishes for specific color requirements:

1. Dryer Wall Caps: Lambro 224 - Series, Primex DV4 - Series. No birdscreen. Gravity backdraft damper. Minimum free area of 12.5 square inches.
2. 4"-8" Exhaust Wall Caps: Primex WC-Series. Provide with birdscreen. Provide with backdraft damper where integral backdraft damper not supplied with exhaust fan.

B. Roof Jack (Pitched Roof): Provide Cook Gemini RJR Series corrosion resistant galvanized steel with black enamel finish, ½" birdscreen. Provide 6" (0-130 cfm) or 8" (131-220 cfm) duct adapter integral back draft damper. Coordinate with Architect finishes for specific color requirements.

1. Roof Jack for Dryers: In-O-Vate Dryer-Jack Model 486.

C. Roof Cap (Flat Roof): Provide Cook Gemini PRF Series all aluminum construction with integral back draft damper and birdscreen.

Size	CFM Range
8	150-300
12	300-800
16	800-1200
20	1200-2000

2.5 LOUVERS

A. Provide Ruskin GFL800 extruded aluminum louvers. Frame shall be 4" (0.081" wall thickness (2), with 6063T5 blades (0.063 wall thickness), J style blades, 45° angle, 5" center to center, 3/4' aluminum bird screen in removable frame.

B. Provide Ruskin ELF extruded aluminum louvers. Frame shall be 4" (0.080 wall thickness (2), with 6063T5 blades (0.081" wall thickness), J style blades, 45° angle, 5" center to center, 3/4' aluminum bird screen in removable frame.

C. Provide Ruskin model BV100 brick vent for sidewall venting of range hoods. Frame shall be extruded aluminum alloy 6063-T5, 0.100 inch nominal wall thickness.

1. Frame Construction: 4 inches (102 mm) frame depth with three 1/8 inch (3 mm) mortar ribs at perimeter.

D. Louvers for sidewall range exhausts shall be Ruskin Model ELF15J, extruded 6063T5 aluminum alloy construction.

1. Frame: 11/2" (38) deep .063" (1.6) wall thickness. Blades: .063" (1.6) nominal wall thickness. Blades are positioned at 45° angle and spaced at approximately 1-7/8" center to center. Bird screen: 3/4" x .051" expanded, flattened aluminum in removable frame. Finish: Select finish specification from Ruskin Finishes Brochure.
2. Straight blades shall be formed aluminum alloy 6063-T5, 0.100 inch nominal thickness, 48 degree angle, 39% nominal free area. Bird screen. Apply alkyd prime coat following chemical cleaning and pretreatment for field painting. Factory assembled vent components. Mechanically fastened construction.

E. Provide Ruskin ELF211 Thinline factory assembled louvers for all sidewall range exhausts with custom kynar color as selected by the architect. Extruded aluminum frame and blades (6063-T5 alloy), 0.060 inch nominal wall thickness. 2" frame depth, flanged. Thinline stationary J blades, 45 degree angle, 3-3/16 inches centers and aluminum ½" mesh bird screen.

2.6 AIR CONTROL DAMPERS

A. Where dampers separate outdoors from indoors, they shall meet the following standards: Use no damper blade that is wider than 6 inches. Construct damper frames from at least 16 gauge, hot dipped galvanized steel. Fit each blade with double sided, inflatable, field replaceable, extruded vinyl edge seals that lock into slots in the blade. Size each blade to fit tightly between flexible, compressible, metal jamb seals. Set nylon bearings in stainless steel sleeves. Use hexagonal shafts for positive blade control. Conceal damper linkage inside the frames and out of the air stream. The entire assembly shall not rattle or vibrate. A closed damper shall not leak more than 4 SCFM per square foot of face area at 1 inches of water column pressure when tested in accordance with AMCA Standard 500D.

2.7 CEILING RADIATION DAMPERS (CRD)

A. Provide ceiling radiation dampers where shown on drawings and in all code required places even if not shown on the drawings. Ceiling radiation dampers and frames shall be UL classified 555C and shall be complete with elevated 212 °F fusible links. The entire assembly and installation shall comply with the requirements

of NFPA #90A and authorities having jurisdiction. For wood, combustible wood truss frame construction damper shall be UL 263 approved.

B. Mount dampers in UL263 rated assembly per manufacturer's instruction. Coordinate damper type with floor-ceiling assembly type.

C. Dampers shall Greenheck CRD Series, butterfly type, rated for a minimum of 1 1/2 hour protection. Coordinate locations of access panel so as to permit replacement of fusible links.

2.8 FIRE DAMPERS

A. Provide fire dampers where shown on drawings and in all code required places even if not shown on the drawings. Fire dampers and frames shall be UL classified 555 and shall be complete with elevated 212 °F fusible links. The entire assembly and installation shall comply with the requirements of NFPA #90A and authorities having jurisdiction.

B. Mount dampers within factory furnished sleeves, which are to be held in place with retaining angles. Frame thickness shall be coordinated with wall thickness.

C. Dampers shall be Greenheck DFD-Series type. Dampers shall be type B or C to allow for nominal 100% free area when in the open position. Coordinate locations of access panel so as to permit replacement of fusible links.

2.9 SMOKE DAMPERS

A. Provide 16-gauge galvanized steel damper blades. Use no damper blade that is wider than 6 inches. Construct damper frames from at least 16-gauge, hot dipped galvanized steel. Fit each blade with silicone rubber edge seals rated to withstand 450°F. for smoke control. Use only dampers rated UL-555S, Leakage Class I. (The UL Class I rating is for 4 SCFM per square foot leakage at 1-inch water column.)

B. Provide each smoke damper with an electric, 120 VAC, two-position operator able to withstand 350°F. The operator shall control the damper unless the temperature responsive device (TRD) releases it. If the TRD releases the damper, it shall remain closed until the TRD can be replaced. The damper shall be normally closed in the event of a power failure.

C. Provide adequately sized rated access panel for actuator and electrical. Coordinate access requirements with the General Contractor.

D. Dampers with in-airstream actuators are allowed however equivalent free area shall be maintained.

2.10 COMBINATION SMOKE/FIRE DAMPERS

A. Provide 16-gauge galvanized steel damper blades. Use no damper blade that is wider than 6 inches. Construct damper frames from at least 16-gauge, hot dipped galvanized steel. Fit each blade with silicone rubber edge seals rated to withstand 450°F. for smoke control and with galvanized steel mating edges for fire control to 1900°F. after the rubber seals have failed. Use only dampers rated UL-555, UL-555S, Leakage Class I and NFPA 90A certified for a 1-1/2 hour fire rating. (The UL Class I rating is for 4 SCFM per square foot leakage at 1-inch water column.)

B. Provide each combination smoke/fire damper with an electric, 120 VAC, two-position operator able to withstand 350°F. The operator shall control the damper unless the temperature responsive device (TRD) releases it. If the TRD releases the damper, it shall remain closed until the TRD can be replaced. The damper shall be normally closed in the event of a power failure.

C. Provide adequately sized rated access panel for actuator and electrical. Coordinate access requirements with the General Contractor.

D. Dampers with in-airstream actuators are allowed however equivalent free area shall be maintained.

E. Dampers installed immediately behind registers shall be UL listed for use out of the wall with internally mounted actuators, Nailor 1221-OW.

F. Dampers installed immediately behind registers shall be UL listed for use out of the wall with 8" wide side panel motor compartment and wrapped with a thermal blanket ACME-FSD-121-SP. Contractor substituting damper with different access compartment width shall be responsible for adjusting register and grille sizes accordingly.

2.11 KITCHEN HOOD EXHAUST

A. Kitchen exhaust ductwork to be 16-gauge steel with liquid tight weld. Duct to slope 2% towards hood or an approved grease collector. Provide cleanouts to comply with Code. Installation of kitchen exhaust ductwork shall comply with NFPA, State and Local Codes.

2.12 DISHWASHER HOOD EXHAUST

A. Exhaust ducts from dishwasher hood connections shall be aluminum above the ceiling and through the roof or to connection to exhaust fan. Aluminum shall be of same thickness as corresponding galvanized sheet.

1. Fabricate seams and joints in dishwasher exhaust liquid tight, caulked with United duct sealer.
2. Exposed ductwork in kitchen and dishwashing room shall be stainless steel

2.13 FLEXIBLE DUCTWORK

A. The flexible duct shall be of semi-rigid construction capable of maintaining the shaping required by job conditions without subsequent sagging or droop. Duct connections to equipment outlet collars shall be made in accordance with the duct manufacturer's recommendations. Maximum flexible air duct length not to exceed 6'-0".

B. Flexible air duct shall be externally insulated with 1/2" thick 3/4 lb. density fiberglass wrapped around twice to 1" thick complete with non-combustible vapor barrier and UL listed.

C. Ductwork and insulation shall be UL listed as Flexible Air Ducts Connection Class I, and meet all NFPA 90A and 90B requirements.

D. Insulated flexible duct shall be Thermaflex M-KE.

E. No flexible ductwork connections shall be allowed in exposed ceiling areas

2.14 ACCESS DOORS

A. Where motorized dampers, fire dampers, control equipment are installed in ductwork, provide suitable sized, gasketed doors in ducts. Doors shall be provided with Ventlok #220 door pull and #90 sash type latches. Use sponge rubber to felt gasketing material on door openings. Access doors in insulated ductwork shall be double wall construction with 1" insulation between wall

2.15 AIR CONTROL DEVICES

A. Provide splitter dampers on all main ducts and where shown on the drawings. Provide Ventlok #690, self-locking splitter assembly on each damper.

B. Provide Clevepak, Type DESC damper extractor with spin-collar at all branch take offs.

C. Provide manual balancing damper at each main branch take-off as well as to each diffuser.

D. In all inaccessible areas, provide balancing damper within reach at each diffuser or register.

E. Provide turning vanes per SMACNA Standards in all square elbows.

2.16 OUTDOOR DUCT SYSTEMS

A. Standard galvanized sheet metal ducts, insulated and jacketed per specification section 23 07 00.

B. Factory manufactured pre-insulated, lined, phenolic duct systems with a minimum R-value of 8.1. Provide galvanized steel external cladding. Coordinate with outdoor duct insulation spec.

Part 3. - EXECUTION

3.1 GENERAL

A. Ductwork behind registers and grilles shall be painted out flat black.

B. Duct sizes shown are free area. Increase duct as a required to accommodate internal insulation.

C. Provide a minimum of 2" wide flexible connectors to all ducted equipment less than 2000 CFM and 4" wide on 2000 CFM and greater.

D. Support all suspended motor and/or fan driven equipment on vibration isolators.

E. Provide heavy mastic sealant at all duct joints to meet duct tightness rating between 1.0 – 5.0 cfm at 25 PA per 100 square feet of conditioned space. Air leakage rate will be verified by a third-party rater.

F. All duct runout shall be to the grille or diffuser neck size unless indicated otherwise.

G. Factory manufactured duct systems shall be installed per manufacturers installation instructions.

3.2 COORDINATION

A. Contractor shall coordinate the routing of all sprinkler piping to maintain 8” minimum clearance from outside air ductwork and ducts or vents that communicate directly with the outdoors within a twenty foot distance from the outside wall penetration**.**

END OF SECTION 23 30 00

SECTION 23 74 00
MAKE-UP AIR ROOFTOP UNITS

Part 1. - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes rooftop heating and cooling units.

1.3 COORDINATION OF DRAWINGS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicated dimensions, weights, loadings, required clearances, method of field assembly, components and location and size of each field connection. Detail mounting, securing and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

D. Maintenance Data: Maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Rating Standard: ANSI/AHRJ 920, "Performance Rating of DX Dedicated Outdoor Air System Units".

C. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings".

D. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The rooftop unit(s) shall be certified in accordance with UL Standard 1995 and ANSI Standard Z21-47.
2. The rooftop unit(s) shall be safety certified by an accredited testing laboratory and the nameplate shall carry the label of the certification agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver rooftop units as factory-assembled units with protective crating and covering as recommended by the manufacturer.

B. Coordinate delivery of units in sufficient time to allow movement into building.

C. Handle rooftop units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.6 COORDINATION

A. Coordination installation of roof curbs, equipment supports and roof penetrations with roof construction. Roof specialties are specified in Division 7 Sections.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fall in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of startup but not to exceed 5 years from date of shipment.
2. Warranty Period, Heat Exchangers: Manufacturers non-prorated full parts replacement not less than 25 years after date of startup or 25 years from date of shipment.

Part 2. – PRODUCTS

2.1 MANUFACTURERS

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

1. Rooftop Units:
   a. Aaon, Innovent, Reznor, Greenheck.

2.2 ROOFTOP UNITS

A. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of Supply and exhaust fan sections, energy recovery wheel, temperature controls, electric heater, filters and dampers.

B. Construction:

1. Unit shall be completely factory assembled, piped and wired and shipped in one section.
2. Unit shall be specifically designed for outdoor rooftop application and with a fully weatherproof cabinet.
3. Cabinet shall be constructed entirely of G90 galvanized steel with the exterior constructed of 20 gauge or heavier material.
4. Paint finish shall be capable of withstanding at least 2000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
5. The unit roof shall be sloped or cross-broken to assure drainage.
6. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided both point-to-point and ladder form.
7. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.

8. Access to filters, blower, heating sections, and other items needing periodic checking or maintenance shall be through hinged access doors with quarter turn latches. Door fastening screws are not acceptable.
9. Access doors shall have stainless steel hinges and full perimeter gasketing.
10. All openings through the base pan of the unit shall have upturned flanges of at least ½" in height around the opening through the base pan.
11. Air side service access doors shall have rain break overhangs.
12. All access doors shall have an internal metal liner to protect the door ½ inch thick, 1 ½ lb. density fiberglass insulation.
13. The interior air side of the cabinet shall be entirely insulated on all exterior panels with 1 inch thick, 1 ½ lb. density fiberglass insulation.
14. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.

C. Supply and/or Relief Fans:

1. Blower(s) shall be entirely self contained on a slide deck for service and removal from the cabinet.
2. All belt drive blower(s) shall have backward inclined airfoil blades.
3. All direct drive blower(s) shall have forward curved blades.
4. Adjustable V-belt drive shall be provided with a minimum rating of 140% of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM.
5. Blowers, drives and motors shall be dynamically balanced. Motors shall be premium efficiency.

D. Outside Air Options:

1. Shall be 0-100% with a 2 position motor operated outside air damper assembly constructed of extruded aluminum, hollow core, air foil blade with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 25 CFM of leakage per sq. ft. of damper area when subjected to 2 in.w.g. air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure. No return air connection shall be present.

E. Energy Recovery:

1. The rooftop unit shall have a factory mounted and tested energy recovery wheel where scheduled on plans. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
2. The energy recovery cassette shall be rated in accordance with ARI Standard 1060 and shall bear the ARI certification symbol.
3. The energy recovery cassette shall contain a total energy recovery heat wheel constructed of a light weight polymer material with permanently bonded desiccant coating. The energy recovery wheel media shall be capable of removal from the cassette and replacement without the use of tools. Wheel media shall be cleanable using hot water or light detergent without degrading the efficiency.
4. The exhaust fan shall be backward inclined type. Fan(s) and motor(s) shall be dynamically balanced. A back draft damper shall be included with the exhaust fan. Outside air filters shall be 2 inch, pleated, disposable.
5. Motors shall be premium efficiency. Motor bearings shall be ball bearing and shall have external lubrication connections.

F. Filters:
   a. First stage: 2-inch-thick, pleated, ASHRAE MERV 8, 30-35% efficiency.
   b. Final stage: 4" thick pleated, ASHRAE MERV 15, 70% efficiency at 3-10 micron particle size..

G. Controls:

1. Make-Up Air Unit Controller:

a. A programmable controller with ambient dewpoint sensor shall be factory mounted internal to the rooftop unit and shall include outputs for sequencing ERV enthalpy wheel.

2. Provide the following options:

a. Single point power with non-fused disconnect and factory wired GFI outlet.
b. Through the bottom electrical connections
c. Five year compressor warranty
d. Duct smoke detectors and all associated wiring, audible/visible alarm devices and all other accessories required for unit shut down and alarm per Code.

H. **ROOF CURBS/PLENUMS**

1. Roof curbs shall be 24" high constructed of galvanized steel. Curbs are to be installed and fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.

Part 3. - EXECUTION

3.1 STARTUP AND COMMISSIONING

A. Factory Service Requirements, Start-Up and Test

1. Contractor shall engage the services of the equipment manufacturer factory trained Service Technician/Engineer, for supervision and recommendations as to the proper installation of the equipment. Service technician is required to provide a certified written report to Architect/Engineer indicating the dates that supervision and recommendations were given to the Contractor and that the entire installation procedure meets with the manufacturer's recommendations. It is the intent of this requirement to ensure that the manufacturer of the equipment is responsible for the installation and operation of their equipment.

2. Complete installation and startup checks according to manufacturer's written instructions and do the following:

(1) Inspect for visible damage
(2) Verify that labels are clearly visible.
(3) Verify that clearances have been provided for servicing.
(4) Provide appropriate programming and setting of dipswitches.
(5) Verify that controls are connected and operable.
(6) Start unit according to manufacturer's written instructions.
(7) Complete startup sheets and attach copy with Contractor's startup report.
(8) Inspect and record performance of interlocks and protective devices; verify sequences.
(9) Operate unit for an initial period as recommended or required by manufacturer.
(10) Inspect controls for correct sequencing.

END OF SECTION 23 74 00

SECTION 23 80 00
HEATING, VENTILATING
AND AIR CONDITIONING

Part 1. – GENERAL

1.1 SUMMARY

A. Contractor shall thoroughly review the manufacturer's installation instructions prior to installing any piece of equipment or its associated service, (gas, hot or chilled water piping, flues, etc.). Any conflicts between the manufacturer's installation instructions and the plans or specification shall be brought to the engineer at once for clarification. Contractor will not receive additional money for installations requiring modifications due to these conflicts.

Part 2. – PRODUCTS

2.1 GENERAL

A. Approved Manufacturers: Listed acceptable manufacturers shall be subject to compliance with specified requirements.

1. Indirect fired Make-up Air Equipment: Weather-Rite, Reznor, Greenheck, Sterling, Rupp, Modine, AbsoluteAire, Greenheck.
2. Supply and Exhaust Fans: Cook, Barry Blower, Penn, Greenheck, Carnes, ACME, Nutone, Broan, S&P (Soler & Palau), Twin City Fan.
3. Ductless Mini-Split Air Conditioners: Daikin, Mitsubishi, Carrier Samsung

B. Condensate:

1. Provide condensate piping from each cooling coil condensate pan to nearest floor drain or common drain riser.
2. Provide an auxiliary drain pan beneath each cooling coil in which condensate will occur.
3. Provide condensate overflow safety switch Little Giant Model ACS-2, 3 or as option Diversitech SOS-1.
4. Wire to shut off the unit served prior to overflow of the pan or sensing water build-up in the condensate piping. Piping shall be sized per Code and manufacturers recommendations with a minimum of ¾".

C. Ductless Split System (AC):

1. Provide a ductless split system heat pump as scheduled, consisting of an indoor high wall mounted or ceiling recessed or ceiling suspended evaporator/blower section and matching outdoor condensing section. Unit will include high efficiency rotary-type compressor, short cycle fire delay and automatic low ambient fan operation. Heat pump shall include an in-line muffler, microprocessor defrost control, self diagnostic service mode, crankcase heater indoor coil high temperature protection and automatic changeover. Provide programmable space thermostat.
2. Provide 3/4" condensate drain from each evaporator drain pan. Route to nearest floor drain or to the exterior 12" above finished grade.

D. Make-Up Air Unit (KMUA):

1. Provide unit completely factory assembled, piped, wired and test fired and as scheduled. Unit shall contain A.G.A. Certified furnace(s) which shall conform to the latest ANSI Standards for safe and efficient performance. Unit shall be suitable for outdoor application and for electric heat.
2. Cabinet: Jacketing shall be die-formed, 20 gauge galvanized steel and finished in air-dry enamel. Service access panel shall be provided through easily removable side access panels with captive

fasteners. Fan sections and supply plenums shall be insulated with fire-resistant, odorless, mat faced one-inch glass fiber material.

3. Heat Exchanger: Construction shall consist of 20 gauge, type 409, stainless steel tubes, seam welded, and 20 gauge headers.
4. Venting Systems: Flue collector construction shall consist of type 409 stainless steel. Unit shall be provided with a square flue cap designed for gravity venting. Outside air for combustion shall enter at the base of the vent cap through a protective grill. Products of combustion shall be discharged through the upper section of the flue vent cap.
5. Burners: Burner construction shall be of type 409 stainless steel.
6. Supply Fans: Fans shall be dynamically balanced for quiet operation and shall contain belt-driven centrifugal fans with adjustable pitch motor sheaves.
7. Motors: Supply fan shall be driven by a continuous duty, open drip-proof electric motor.
8. Controls:

    a. A factory installed control box or junction box shall be provided for all power connections. Provide a 24 volt control transformer, high limit and fan time delay relay.

9. Provide the following options:
    a. Cooling coil section.
    b. Single point power with non-fused disconnect and factory wired GFI outlet.
    c. Rain hood and wire mesh inlet screen.
    d. Insulated roof curb.
    e. Discharge plenum to provide downflow discharge.
    f. 2-inch washable permanent type filters.
    g. Two position motorized discharge damper.
    h. Remote panel complete with operating lights to indicate blower on and burner on, discharge air temperature adjustment, summer-off-winter selector switch.

E. Exhaust Fans (EF):

1. Provide a ceiling in-line blower as scheduled. In-line duct blower units shall be of the direct drive, forward curved centrifugal blower type. Motor and blower assembly shall be permanently lubricated. Motor shall be provided with means of disconnect. Unit shall come with a white ceiling grille. Unit shall be UL listed and AMCA rated.
2. Provide a power roof ventilator as scheduled. The fan shall be all aluminum construction, centrifugal, adjustable belt drive, all aluminum insulated roof curb. Motor overload protection and UL rating is required. Provide the highest quality motorized damper option provided by the manufacturer for a fan of this type (edge seals). Fans shall be AMCA rated. Coordinate the roof curb flashing and installation requirements with the general contractor.
3. Provide a power roof ventilator Greenheck serving the kitchen hood as scheduled. The fan shall be UL and NFPA 96 rated for kitchen hood exhaust applications. Fan shall be belt drive, steel construction, out of stream air cooling for the motor, variable pitch sheaves, fans shall be AMCA rated and have clean-out port on housing. Provide temperature sensor to energize fan allowing automatic interlock operation.

    a. Provide matching steel roof curb with vented extension.
    b. Provide access panels and welded steel duct construction. The duct shall extend 18 inches above the roof, the fan shall be hinged on the curb and shall have a 40" minimum discharge height above the roof.
    c. Provide a complete G2 Grease Guard system as manufactured by Facilitec Corporation (1-800-284-8273). Frame shall be anodized aluminum with molded corners. Grease containment materials shall include: Top pre-filter, filter composite with transfer layer, absorption layer and a barrier layer, bottom filter and fire shield. Provide with fiberglass hold down poles and connectors. Provide galvanized steel grease deflecting flashing with UV stable copolymer corners. Provide elevation kit for pitched roof installations.

4. Provide an in-line centrifugal fan Greenheck as scheduled. Square 16 gauge housing, hinged access door, straightening vanes, all aluminum centrifugal backward inclined, non overloading blower wheel, bearings isolated from air stream, motor guard, permanently lubricated motors, vibration isolators, AMCA rated.

F. Relief Air Hoods:

1. Provide hoods as shown (Broan, Penn, Cesco, Greenheck, S&P (Soler & Palau)). Units shall be all galvanized construction complete with birdscreen and backdraft damper. For dryer ducts provide Broan Model 644 of all aluminum construction, birdscreen.

G. Pool Dehumidification Unit:

1. Furnish and install pool dehumidification system capable of providing dehumidification, air heating/cooling Dectron (PoolPak, Desertairre, DCA, Seresco).
2. The dehumidifiers shall be single package units. Each unit shall include compressor, evaporator (dehumidifying coil), condenser (air reheat coil), water heater (s), supply air blower, blower motor, motor starters and controls in one complete enclosure. All controls shall be factory adjusted and preset to the design conditions. The unit shall be designed for indoor installation.
3. Cabinet:
   a. The cabinet shall be constructed of 16 gauge satin coated sheet metal, reinforced for maximum rigidity with a 14-gauge base. Removable service panels shall be furnished to provide access to all internal parts from both sides and in each section. The unit shall have a built-in air filter rack with separate access door.
   b. Each unit shall have a built-in electrical control panel in a separate compartment.

4. Insulation:
   a. Entire coil section shall be insulated to prevent condensation with ½ inch thick fiberglass duct liner insulation, approved for 250°F operating temperature and up to 5,000 fpm air velocity. Surface to be protected against perforation with a reinforcing mesh. Fire resistance rating to conform with NFPA Standard 90A. Sound attenuation coefficient shall be not less than 0.64 at a frequency of 1000Hz as per ASTM Standard C423. Thermal conductivity shall be not more than 0.232 Btu•in/h•sq ft•°F at 75°F.

5. Evaporator (Dehumidifier Coil):
   a. Shall not be less than eight rows deep, air velocity not to exceed 500 fpm, with ½ inch OD seamless copper tubing mechanically expanded and maximum twelve flat aluminum fins per inch. Corrugated, facetized or copper fins are not acceptable. Coil shall have a 16-gauge galvanized casing and coated end plates. Coil shall be factory tested at air pressures not less than 400 psig in a water bath.

6. Condenser (Air Reheat Coil):
   a. Shall not be less than three rows deep with 5/8 inch OD seamless copper tubing mechanically expanded with maximum twelve facetized aluminum fins per inch. Copper fins shall not be acceptable. Coil shall have a 16-gauge galvanized casing and coated end plates. Coil shall be factory tested at air pressures not less than 400 psig in a water bath.

7. Drain Pan:
   a. Provide a sloped non-trapping drain pan under the entire evaporator coil to prevent condensate carry-over. Flat drain pans are not acceptable. The drain pan shall be made of 12-gauge grey Noryl plastic with hair cell finish or 316 stainless steel.

8. Blower and Motor:
   a. Provide a double width, double inlet, multi-blade forward curved centrifugal type blower wheel, dynamically and statically balanced and tested, mounted on a solid steel shaft coated with

silicon. Blower shall have a galvanized steel and galvanized steel casing painted with a baked enamel finish. Bearings shall be grease-lubricated, self-aligning for 200,000 hours average life.

b. Blower Motor shall be high efficiency, open drip-proof, class B insulation, induction type 40°C rise, pre-lubricated ball bearings mounted on an adjustable base, with a service factor rating of 1.15 or higher.

c. Blower Belt Drive Assembly shall be single V-belt with a safety factor not less than 1.2 based on nominal motor horsepower, dynamically balanced cast iron fixed pitch blower sheave and dynamically balanced cast iron variable pitch motor sheave.

9. Compressor:
   a. Unit shall have hermetic compressor, suction gas cooled, suitable for refrigerant R-22, equipped with internal solid state sensor thermal protection, resilient type external mounting and easily removable external crankcase heater for liquid migration protection.
   b. Compressor manufacturer must have a wholesale outlet for replacement parts in the nearest major city.
   c. Compressor shall have a 5-year extended warranty.

10. Refrigeration Circuit:
   a. Shall have an in-line solder type liquid line filter drier, liquid and moisture indicator visible from outside the unit without removal of the access panel and thermostatic expansion valve.
   b. Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schraeder type valves.
   c. Refrigeration service valves shall be located outside of the airstream.
   d. Suction line shall be fully insulated with not less than ½ inch closed cell insulation.

11. Controls:
   a. Provide operating control sequence per Dectron specifications to perform air conditioning, auxiliary heat and automatic changeover functions.
   b. Compressor shall be controlled by contactors.
   c. Blower motor and compressor shall be protected with push-button operated, adjustable thermal trip and fixed magnetic trip overloads.
   d. Power block terminal shall be provided for proper wire size.
   e. A dry contact shall be provided for alarm.
   f. Compressor shall have a time delay start to prevent short cycling.
   g. All wiring shall be installed in accordance with UL or CSA safety electrical code regulations and shall be in accordance with NFPA. All components used shall be US or CSA listed.
   h. Unit shall be monitored and controlled with a solid state microprocessor system with remote mounted control panel located in the pool room.
   i. The following LED indications shall be provided on the remote control panel:

      1) System On
      2) Dehumidify
      3) Pool Water Heat
      4) Cool
      5) Aux Heat
      6) Service Light to Detect
         (i) Sensor failures.
         (ii) Dirty air filter and blocked air filter.
         (iii) Refrigerant high and low pressure.
         (iv) High and low dew point.
         (v) System off.
         (vi) Anti-short cycle delay

   j. The remote control panel shall have adjustable temperature and humidity setpoints
   k. The following sensors shall be factory mounted in the unit:

1) Return air temperature.
2) Supply air temperature.
3) Air off evaporator temperature.
4) Return air relative humidity.

l. Provide pool water temperature sensor and provide wiring to control panel.

12. Air Filter:

a. Shall be 1 inch Merv 7, disposable type suitable for commercial application.

13. Auxiliary Heat:

a. Auxiliary heat shall be as specified. Provide control wiring to pool system control panel.

14. Air Cooled Air Condenser:

a. Unit shall be equipped with an outdoor air cooled condenser. The outdoor condenser shall be equipped with transformer and 24VAC control including contactor for fan motor.
b. Unit shall be provided with a dry contact rated for 24VAC/8A to operate the remote outdoor condenser control.
c. Refrigeration circuit shall include three-way refrigerant valve, receiver with pressure relief valve set at 400 psig sized to hold the outdoor condenser charge, pressure control valve and pressure differential valve and two shutoff valves to isolate the outdoor condenser.

15. Provide manufacturer's field training and start up for owner's staff.

H. Electrical Duct Heater (EDH):

1. Duct heaters shall be Indeeco (Neptronics, Thermolec).
2. Heaters shall meet the requirements of the National Electrical Code and shall be listed by Underwriters' Laboratories for zero clearance to combustible surfaces.
3. Heating elements shall be finned tubular construction.
4. Heater frames and terminal boxes shall be corrosion-resistant steel.
5. All heaters shall be furnished with a disc type, automatic reset thermal cutout for primal over-temperature protection. Heaters shall also be furnished with disc type, load-manual reset thermal cutouts, factory wired in series with heater stages for secondary protection. Heat limiters or other fusible over-temperature devices are not acceptable.
6. Provide thermal cutouts, airflow switch, contactors, fuses (if over 48 amps), control circuit transformer (where required) and built-in, snap-acting, disconnect switch with door interlocking safety.

Part 3. - EXECUTION

3.1 GENERAL

A. Installation:

1. Equipment mounted on the roof shall be rigidly fastened with vibration isolators on curbs or rails that are flashed to the roof. Coordinate flashing with roofing contractor. Air cooled condensers and heat pumps of 5 ton capacity or less shall be rigidly fastened to a pre-cast mounting pad. Roof shall be protected from concrete pad with 1" rigid foam insulation or etha foam. Roofing contractor shall approve method and product used.
2. Support all suspended and floor mounted, motor and/or compressor driven equipment on spring isolators.

3. All floor mounted equipment shall be set at 4” high concrete curbs extending 2” beyond the equipment footprint.

END OF SECTION 23 80 00

SECTION 23 81 29
VARIABLE REFRIGERANT FLOW SPLIT SYSTEM

Part 1. – GENERAL

1.1 SUMMARY

A. Contractor shall thoroughly review the manufacturer's installation instructions prior to installing any piece of equipment or its associated service, (gas, hot or chilled water piping, flues, etc.). Any conflicts between the manufacturer's installation instructions and the plans or specification shall be brought to the engineer at once for clarification. Contractor will not receive additional money for installations requiring modifications due to these conflicts.

Part 2. – PRODUCTS

2.1 GENERAL

A. Approved Manufacturers:

1. Variable Refrigerant Flow Zoning Split System: Mitsubishi Electric Trane US (METUS) City-MULTI VRFZ, Daikin, LG.

2.2 PRODUCTS

A. Auxiliary Condensate Drain Pan:

1. Provide an auxiliary drain pan beneath each cooling coil in which condensate will occur.
2. Provide condensate overflow safety switch shall be Little Giant Model ACS-2, 3 (DPLS1 Mini/Multi Split Drain Pan Level Sensor).
3. Install switch in the condensate drain pan of the cooling unit and wire to shut off the unit if the condensate level in the drain pan approaches overflow.

B. Variable Refrigerant Flow Zoning Split System: Mitsubishi Electric Trane US (METUS) City – MULT VRFZ

1. The variable capacity air conditioning system shall be a Mitsubishi Electric Trane US (METUS) CITY MULTI VRFZ (Variable Refrigerant Flow Zoning) System. The CITY MULTI VRFZ systems shall be the R2-Series, simultaneous cooling and heating split system.
2. The basis of design is a 2 pipe VRF system and in the event the mechanical contractor installs a non-basis 3 pipe system, any and all cost changes from the base 2 pipe system shall be 100% born by the mechanical contractor. Minor downstream changes to 3 pipe systems, such as capacity changes and / or line length changes, can result in all of the upstream pipe changing diameter. Any changes like this, resulting either from a valid change order or field conditions, shall not result in additional cost or delays to the owner
3. The R2-Series system shall consist of a TURY outdoor unit, BC (Branch Circuit) Controllers, multiple indoor units TPMFY/TPEFY models and one TE-50A Centralized Controller. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. Each indoor unit or group of indoor units shall be independently controlled.
4. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

5. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
6. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
7. Warranty: The CITY MULTI units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the original owner from date of installation.
8. If the systems are:
    a. Designed by a certified CITY MULTI Diamond Designer.
    b. Installed by a certified CITY MULTI Diamond Dealer and 3) verified with a completed commissioning report submitted to Mitsubishi Electric Service Department, then the units shall be covered by an extended manufacturer's limited parts and compressor warranty for a period of ten (10) years to the original owner from date of installation. This warranty shall not include labor. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.
9. Manufacturer shall have a minimum of twenty-five years of HVAC experience in the U.S. market.
10. The CITY MULTI VRFZ system shall be installed by a Mitsubishi authorized CITY MULTI Diamond Dealer with extensive CITY MULTI install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

C. Fan Coil Indoor Unit – TPKFY (WALL-MOUNTED)

1. General:
    a. The PKFY shall be wall-mounted indoor unit section with a slim silhouette and shall have a modulating linear expansion device. The TPKFY shall be used with the R2-Series outdoor unit and BC Controller.
2. Indoor Unit:
    a. The indoor unit shall be completely factory assembled and tested including factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
    b. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
    c. The TPKFY shall be wall-mounted indoor unit section with a slim silhouette and shall have a modulating linear expansion device. The TPKFY shall be used with the R2-Series outdoor unit and BC Controller, Indoor Unit.
3. Unit Cabinet:
    a. The casing shall have a white finish.
    b. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
    c. There shall be a separate back plate which secures the unit firmly to the wall.
4. Fan:
    a. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
    b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
    c. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
5. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
6. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
    a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.

b. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
c. The coils shall be pressure tested at the factory.
d. Both refrigerant lines to the PKFY indoor units shall be insulated.
e. A condensate pan shall be located in the unit.

7. Control:
   a. The unit shall have controls provided by Mitsubishi authorized CITY MULTI to perform input functions necessary to operate the system.
   b. See 15910 Automatic Temperature Controls.
8. Filter: Return air shall be filtered by means of an easily removable, washable filter.

D. Fan Coil Indoor Unit – TPEFY (Ceiling Concealed Ducted)

1. General:
   a. The TPEFY shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device.
   The TPEFY` shall be used with the R2-Series outdoor unit and BC Controller.
2. Indoor Unit:
   a. The indoor unit shall be completely factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
3. Unit Cabinet:
   a. The cabinet shall be located into the ceiling and ducted to the supply and return openings. The unit shall be space saving, ceiling-concealed, ducted.
   b. The cabinet panel shall have provisions for a field installed filtered outside air intake. Optional high efficiency air filters are available for each model unit.
4. Fan:
   a. The fan shall be direct-drive Sirocco type fan, statically and dynamically balanced impeller with high and low fan speeds available.
   b. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
   c. The indoor unit shall have a ducted air outlet system and ducted return air system.
5. Coil:
   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   b. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   c. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
   d. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
   e. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
   f. The coils shall be pressure tested at the factory.
   g. A condensate pan and drain shall be provided under the coil. The condensate shall be gravity drained from the fan coil.
   h. Both refrigerant lines to the PDFY indoor units shall be insulated.

E. R2-Series TURY Outdoor Unit

1. General:

a. The R2-Series TURY outdoor unit shall be used specifically with CITY MULTI VRFZ components.
b. The TURY outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation.
c. The outdoor unit shall have a powder coated finish.

2. The outdoor unit:
   a. Shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
   b. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.
   c. Outdoor unit shall have a sound rating no higher than 63 dB (A).
   d. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated.
   e. There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.
   f. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via Linear Expansion Valves (LEV) from the heat exchanger.
   g. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection.
   h. I would let the piping diagram and layout determine the requirement. The outdoor unit shall be capable of operating in heating down to -4°F ambient temperature without additional low ambient controls.
   i. The outdoor unit shall not cease operation in any mode based solely on outdoor ambient temperature.
   j. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
   k. While in hot gas defrost the system shall slow the indoor unit fan speed down to maintain a high discharge air temperature, systems that keep fan running in same state shall not be allowed as they provide an uncomfortable draft to the indoor zone due to lower discharge air temperatures.
   l. VRF four-legged outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7-gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.

3. Unit Cabinet:
   a. The casing(s) shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

4. Fan:
   a. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG. external static pressure, but capable of normal operation with a maximum of 0.32 in. WG. external static pressure via dipswitch.
   b. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
   c. All fan motors shall be mounted for quiet operation.
   d. All fans shall be provided with a raised guard to prevent contact with moving parts.
   e. The outdoor unit shall have vertical discharge airflow.

5. Refrigerant
   a. R410A refrigerant shall be required for TURY outdoor unit systems.
   b. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety

data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

c. Refrigerant line sizing shall be in accordance with manufacturer specifications. Future changes to indoor unit styles or sizes must be possible without resizing/replacing refrigerant piping to any other branch devices or indoor units.

6. Coil:
   a. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil
   b. Outdoor Coil shall be elevated at least 12" from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturer's in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12" of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be the responsibility of Mechanical Contractor to provide.
   c. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.
   d. The coil shall be protected with an integral metal guard.
   e. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
   f. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.
   g. Outdoor unit shall include Variable Evaporator Temperature or comparable method of varying system evaporator (refrigerant) temperature in order to reduce compression ratio and power consumption during light load or mild ambient temperatures. Multiple evaporator refrigerant temperature settings shall be required in order to optimize efficiency within required system-specific performance and installation constraints. System shall reduce compression ratio only when/if all indoor units are within 1.8F of setpoint; reducing compression ratio based solely on ambient temperature risks discomfort and is not allowed. Variable Evaporator Temperature or comparable method shall incorporate override or disable capability based on external signal to allow for space humidity control or load demand. The unit shall be an integral part of the system & control network described in Part 5 (Controls) and react to heating/cooling demand as communicated from connected indoor units over the control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.

7. Compressor:
   a. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
   b. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.
   c. A crankcase heater(s) shall be factory mounted on the compressor(s).
   d. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to 16% of rated capacity.
   e. The compressor will be equipped with an internal thermal overload.
   f. The compressor shall be mounted to avoid the transmission of vibration.

8. Electrical:
   a. The outdoor unit electrical power shall be 208/230 volts, 3-phase, 60 hertz.
   b. The outdoor unit shall be capable of satisfactory operation within voltage limits 207-253V (230V/60Hz).
   c. The outdoor unit shall be controlled by integral microprocessors. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable.

F. Branch Circuit (BC) Controllers for R2-Series Systems

1. General:
   a. The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems.
   b. BC (Branch Circuit) Controllers (or comparable branch devices) shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices which do not include controlled refrigerant subcooling risk bubbles in liquid supplied to indoor unit LEVs and are not allowed.
   c. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation.
   d. The unit shall have a galvanized steel finish.
   e. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors.
   f. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
   g. VRF Manufacturer's requiring more than specified branch devices shall include system layout and drawing prior to bidding to ensure branch device locations are acceptable by owner. VRF manufacturer shall pay for any additional costs associated with excess branch devices.
2. BC Unit Cabinet:
   a. The casing shall be fabricated of galvanized steel.
   b. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
   c. The unit shall house two tube-in-tube heat exchangers.
3. Refrigerant
   a. R410A refrigerant shall be required for CMB-P-NU-G/GA/GB BC Controllers in conjunction with PURY-P-TGMU-A outdoor unit systems.
   b. Refrigerant valves: The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and/or three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
   c. Each branch shall have multiple two-position valves to control refrigerant flow.
   d. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
   e. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
   f. Integral Drain Pan: An integral condensate pan and drain shall be provided.
4. Electrical:
   a. The unit electrical power shall be 208volts, 1 phase, 60 hertz.
   b. The unit shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz).
   c. The BC Controller shall be controlled by integral microprocessors.
   d. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

G. CITY MULTI Controls

1. The CITY MULTI consists of zone controllers (one per air handling unit or zone) and the TE—50A Centralized Controller. Provide power supply to supply 12VCD for the TE-50A centralized controller(s) and 24VDC voltage for the central control transmission. The CITY MULTI Controls Network shall support operation, monitoring, scheduling and managing up of the number of zones indicated.
2. Private Rooms: Provide Deluxe MA Remote controller. Provide run and stop operation for a single group Switches between Cool/Dry/Auto/Fan/Heat. Operation modes vary depending on the air conditioner unit. Auto mode is in the R2-Series only. ON/OFF/Temperature setting. The range of room temperature setting shall be limited by the initial setting. The lowest limit temperature shall be made higher than the usual (67ºF) (adj) in cool/dry mode, while the upper limit temperature lower than usual (83ºF) (adj) in heat mode.
3. Public and Common Areas:
4. Provide TE-50A controller and software to provide capability of web-based computer interface building automation system for remote monitoring and control. Provide all boards, accessories, modules, etc. required.
5. The Master Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three expansion controllers. The Master Centralized Controller shall be approximately 11-5/32” x 7-55/64” x 2-17/32” in size and shall be powered with an integrated 100-240 VAC power supply. The Master Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the Master Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the Master Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the master provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Master Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.
6. Provide Building Connect Plus Network controller to allow web-based remote access.

H. TPLFY (4-way ceiling-recessed cassette with grille) Indoor Unit

1. General:
   a. The TPLFY shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
2. Unit Cabinet:
   a. The cabinet shall be space-saving ceiling-recessed cassette.
   b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
   c. Branch ducting shall be allowed from cabinet.
   d. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
   e. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space.
3. Fan:
   a. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.

b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
c. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
d. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature.
e. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
f. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
g. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
h. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.
i. If specified, the grille shall have an optional i-see sensor that will measure room temperature variations and adjust the airflow accordingly to evenly condition the space.

4. Filter:
   a. Return air shall be filtered by means of a long-life washable filter
5. Coil:
   a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b. The tubing shall have inner grooves for high efficiency heat exchange.
   c. All tube joints shall be brazed with phos-copper or silver alloy.
   d. The coils shall be pressure tested at the factory.
   e. A condensate pan and drain shall be provided under the coil.
   f. The unit shall include a condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.
   g. Both refrigerant lines to the PLFY indoor units shall be insulated.
6. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
7. Controls:
   a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.

I. TPLFY (4-way ceiling-recessed cassette with grille) Indoor Unit

1. General:
   a. The TPLFY shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
2. Unit Cabinet:
   a. The cabinet shall be a compact 22-7/16” wide x 22-7/16” deep so it will fit within a standard 24” square suspended ceiling grid.
   b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
   c. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
3. Fan:
   a. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
   b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   c. The indoor fan shall consist of three (3) speeds, Low, Mid, and High.

d. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
e. The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.

4. Filter:
   a. Return air shall be filtered by means of a long-life washable filter.
5. Coil:
   a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b. The tubing shall have inner grooves for high efficiency heat exchange.
   c. All tube joints shall be brazed with phos-copper or silver alloy.
   d. The coils shall be pressure tested at the factory.
   e. A condensate pan and drain shall be provided under the coil.
   f. The unit shall include a condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
   g. Both refrigerant lines to the PLFY indoor units shall be insulated.
6. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
7. Controls:
   a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.

J. TPMFY (1-way ceiling-recessed cassette with grille) Indoor Unit

1. General:
   a. The TPMFY shall be a one-way cassette indoor unit that recesses into the ceiling with a ceiling grille and shall have a modulating linear expansion device. The TPMFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PMFY shall support individual control using M-NET DDC controllers.
2. Indoor Unit:
   a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
3. Unit Cabinet:
   a. The cabinet shall be space-saving ceiling recessed.
   b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
   c. Branch ducting shall be allowed from cabinet.
   d. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.
4. Fan:
   a. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.
   b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   c. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.
5. Filter:
   a. Return air shall be filtered by means of a long-life washable filter.
6. Coil:
   a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b. The tubing shall have inner grooves for high efficiency heat exchange.
   c. All tube joints shall be brazed with phos-copper or silver alloy.
   d. The coils shall be pressure tested at the factory.
   e. A condensate pan and drain shall be provided under the coil.

f. The condensate lift mechanism shall be able to raise drain water 23 inches above the condensate pan.
g. Both refrigerant lines to the TPMFY indoor units shall be insulated.

7. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

8. Controls:
   a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

K. TPEFY (low profile ceiling-concealed ducted) Indoor Unit

1. General:
   a. The TPEFY (Low Profile) unit shall be a high-performance ceiling-concealed ducted indoor fan coil that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The TPEFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY-NMLU shall support individual control using M-NET DDC controllers. TPEFY (Low Profile) models shall have an extremely compact profile (8-7/8") which requires minimal ceiling space.
2. Indoor Unit:
   a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
3. Unit Cabinet:
   a. The cabinet shall be space saving, low profile, ceiling-concealed ducted.
   b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
4. Fan:
   a. The indoor unit fan shall be an assembly with one Sirocco fan direct driven by a single motor.
   b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   c. The indoor fan shall consist of three (3) speeds, High, Mid, and Low.
   d. The indoor unit shall have a ducted air outlet system and ducted return air system.
5. Filter:
   a. Return air shall be filtered by means of a standard factory installed return air filter.

6. Coil:
   a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b. The tubing shall have inner grooves for high efficiency heat exchange.
   c. All tube joints shall be brazed with phos-copper or silver alloy.
   d. The coils shall be pressure tested at the factory.
   e. A condensate pan and drain shall be provided under the coil.
   f. The condensate shall be gravity drained from the fan coil.
   g. Both refrigerant lines to the TPEFY indoor units shall be insulated.
7. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

8. Controls:
    a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

L. TPEFY (ALTERNATE HIGH STATIC OPTION, CEILING-CONCEALED DUCTED) INDOOR UNIT

1. General:
    a. The TPEFY (Alternate High Static Option) unit shall be a high-performance ceiling concealed ducted indoor fan coil that mounts above the ceiling with a fixed rear return and a horizontal discharge supply, and shall have a modulating linear expansion device. The TPEFY- shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The TPEFY shall support individual control using M-NET DDC controllers. TPEFY (Alternate High Static Option) models shall feature external static pressure settings up 0.80 in. WG (230 Volts.
2. Indoor Unit:
    a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
3. Unit Cabinet:
    a. The cabinet shall be ceiling-concealed, ducted.
    b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
4. Fan:
    a. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
    b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
    c. The indoor unit shall have a ducted air outlet system and ducted return air system.
5. Filter:
    a. Return air shall be filtered by a field-supplied filter.
    b. Optional rear return filter box with long-life filter shall available for all TPEFY indoor units.
6. Coil:
    a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
    b. The tubing shall have inner grooves for high efficiency heat exchange.
    c. All tube joints shall be brazed with phos-copper or silver alloy.
    d. The coils shall be pressure tested at the factory.
    e. A condensate pan and drain shall be provided under the coil.
    f. The condensate shall be gravity drained from the fan coil.
    g. Both refrigerant lines to the TPEFY indoor units shall be insulated.

7. Electrical:
    a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz, except for the TPEFY-P72NMHU-E and PEFY-P86NMHU-E. The PEFY-P72NMHU-E and PEFY-P96NMHU=E shall be 208/230 volts, 3-phase, 60 hertz.
    b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
8. Controls:
    a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

M. TPFFY (FLOOR-STANDING-EXPOSED or FLOOR-STANDING-CONCEALED) INDOOR UNIT

1. General:
   a. The TPFFY shall consist of a floor-standing indoor section with and shall have a modulating linear expansion device. TThe PFFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit.
   b. The TPFFY shall support individual control using M-NET DDC controllers.
2. Indoor Unit:
   a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
3. Unit Cabinet, Exposed:
   a. The casing shall have a beige Acrylic paint finish.
4. Unit Cabinet, Recessed:
   a. The casing shall have a galvanized sheet metal finish.
5. Fan:
   a. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
   b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   c. The indoor fan shall consist of two (2) speeds, High and Low.
6. Filter:
   a. Return air shall be filtered by means of an easily removable washable filter.
7. Coil:
   a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b. The tubing shall have inner grooves for high efficiency heat exchange.
   c. All tube joints shall be brazed with phos-copper or silver alloy.
   d. The coils shall be pressure tested at the factory.
   e. A condensate pan and drain shall be provided under the coil.
   f. Both refrigerant lines to the TPFFY indoor units shall be insulated.
8. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
9. Controls:
   a. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

N. TPCFY (CEILING-SUSPENDED) INDOOR UNIT

1. General:
   a. The TPCFY shall be ceiling-suspended indoor unit section providing powerful airflow and shall have a modulating linear expansion device. The TPCFY shall be used with the R2-Series outdoor unit and BC Controller(s), Y-Series outdoor unit, or S-Series outdoor unit. The TPCFY shall support individual control using M-NET DDC controllers.
2. Indoor Unit:
   a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

3. Unit Cabinet:
   a. The casing shall have a white finish.
4. Fan:
   a. The indoor unit fan shall be an assembly with two, three, or four Sirocco fan(s) direct driven by a single motor.
   b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   c. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.
5. Filter:
   a. Return air shall be filtered by means of an easily removable, washable filter.
6. Coil:
   a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b. The tubing shall have inner grooves for high efficiency heat exchange.
   c. All tube joints shall be brazed with phos-copper or silver alloy.
   d. The coils shall be pressure tested at the factory.
   e. A condensate pan and drain shall be provided under the coil.
   f. Both refrigerant lines to the TPCFY indoor units shall be insulated.
7. Electrical:
   a. The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
   b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

Part 3. – EXECUTION

3.1 STARTUP AND COMMISSIONING

A. Factory Service Requirements, Start-Up and Test

1. Contractor shall engage the services of the equipment manufacturer factory trained Service Technician/Engineer, for supervision and recommendations as to the proper installation of the equipment. Service technician is required to provide a certified written report to Architect/Engineer indicating the dates that supervision and recommendations were given to the Contractor and that the entire installation procedure meets with the manufacturer's recommendations. It is the intent of this requirement to ensure that the manufacturer of the equipment is responsible for the installation and operation of their equipment.

2. Complete installation and startup checks according to manufacturer's written instructions and do the following:

   a. Inspect for visible damage.
   b. Verify that labels are clearly visible.
   c. Verify that clearances have been provided for servicing.
   d. Provide proper charge of refrigerant and oil.
   e. Provide appropriate programming and setting of dipswitches.
   f. Verify that controls are connected and operable.
   g. Start unit according to manufacturer's written instructions.
   h. Complete startup sheets and attach copy with Contractor's startup report.
   i. Inspect and record performance of interlocks and protective devices; verify sequences.
   j. Operate unit for an initial period as recommended or required by manufacturer. Inspect controls for correct sequencing.

END OF SECTION 23 81 29

SECTION 23 82 00
ELECTRIC SPACE HEATING EQUIPMENT

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide electric space heating equipment wherever required by the Drawings and Specifications.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 23 00 10.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All electric space heating equipment shall be as follows:

1. Chromalux
2. Berko
3. Fasco
4. Indeeco
5. Markel
6. Qmark
7. Raywall

2.2 PRODUCT

A. Baseboard Heaters (Berko numbers are provided for cross referencing):

1. BB-X: Berko #CSLAS-Series with integral thermostat and disconnect. Length, voltage and wattage as scheduled.

B. Fan Forced Wall Heaters (Berko numbers are provided for cross referencing):

1. FF-X: Berko #FRC- Series, with integral tamper proof thermostat and disconnect. Voltage and heating capacity as scheduled.

C. Fan Forced Wall Heaters (Berko numbers are provided for cross referencing):

1. FF-X: Berko FRA or SRA-Series, with integral thermostat and disconnect, tamper proof front cover. Voltage and heating capacity as scheduled.

D. Ceiling Mounted Fan Forced Heaters (Berko numbers are provided for cross referencing):

1. CFF-X: Berko QFF-Series, with remote thermostat and integral disconnect. Voltage and heating capacity as scheduled.

E. Electric Utility Heaters (Berko numbers are provided for cross referencing):

1. EH-X: Berko PHT-500, with, integral thermostat and disconnect. Voltage as scheduled.

F. Electric Horizontal Unit Heaters (Berko numbers are provided for cross referencing):

1. EUH-X: Berko HUHAA-Series, with integral thermostat and disconnect. Voltage and wattage as scheduled.

G. Cove Heaters (Berko numbers are provided for cross referencing):

1. ECH-X: Berko #CHC-Series. Length, voltage and wattage as scheduled.

H. Radiant Ceiling Panels (Berko Numbers are provided for cross referencing):

1. ERH-X: Berko CP-Series. Provide mounting kit for recessed or surface mounting as scheduled. Provide size, voltage and capacity as scheduled.

I. Wall Mounted Timer Switch (Leviton numbers are provided for cross referencing):

1. TS-1: Timer switch, 0-30 minute, with four preset buttons and one off button. Leviton #LTB30-1L.
2. TS-2: Timer switch, 0-60 minute, with four preset buttons and one off button. Leviton #LTB60-1L.

Part 3. – EXECUTION

3.1 INSTALLATION

A. General Requirements: When shown on plan or specified, the Contractor shall provide a line voltage, remote thermostat for control of electric space heating equipment. Exact location shall be coordinated with Architect.

END OF SECTION 23 82 00

SECTION 23 82 23
VARIABLE FREQUENCY DRIVES

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Include labor, materials, equipment and accessories to install a complete adjustable frequency motor drive consisting of a pulse width modulated (PWM) inverter for use on a standard NEMA Design B induction motor. The drive shall be manufactured in the USA. The drive shall be designed specifically for variable torque applications.

1. Variable frequency systems shall be for continuous duty and shall be suitable for fan or blower service.
2. The drive and all necessary controls, as herein specified shall be supplied by the drive manufacturer. Manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten years.
3. Provide an integral bypass motor starter package and non-fused disconnect.
4. All VFD's installed on this project shall be from the same manufacturer.

1.2 REFERENCES

A. National Electric Code (NEC).

B. National Electrical Manufacturers Association (NEMA).

C. Underwriter's Laboratories, Inc.

D. Standard 519-1992, IEEE Guide for harmonic Content and Control.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Variable frequency drive controller shall be capable of accepting an electronic signal to determine quantity of air required and resultant frequency and voltage output to satisfy conditions.
2. Unit shall require one incoming power connection. Wiring from VFD controller to motor shall be by Electrical Contractor.

B. The following are options:

1. Input line fuses shall provide protection for the input rectification circuit using Class J fuses with interrupting rating of 200,000 AOIC. The series interrupting rating of the VFD and fuses shall be a minimum of 25,000 AIC and shall be stated on the VFD nameplate by UL.
2. A main input disconnect shall mount within the standard NEMA 1 enclosure for positive power disconnect of the VFD. It shall have the capability for door padlocking.

1.4 SUBMITTALS

A. Shop Drawings: Submit a portfolio to include the following:

1. Outline Dimensions.
2. Weight.
3. Customer connection and power wiring diagrams.
4. Typical efficiency vs. speed graph for variable torque load.
5. Compliance to IEEE 519 - Harmonic analysis for particular jobsite including total voltage harmonic distortion and total current distortion.

a. The VFD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided by the VFD manufacturer to ensure compliance with IEEE standard 519-1992, Guide for Harmonic Control and Reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior to VFD installation.
b. Prior to installation, the VFD manufacturer shall provide the estimated total harmonic distortion (THD) caused by the VFD's. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user. Documents required for the calculations may be purchased at the Architect/Engineer's office.
c. If the voltage THD exceeds 5%, the VFD manufacturer shall recommend additional equipment required to reduce the voltage THD to an acceptable level.

1.5 QUALITY ASSURANCE

A. Qualifications: It is required that the drive manufacturer shall have the following:

1. A sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
2. An independent service organization.
3. A parts stocking depot local to the installation site.

B. Testing:

1. All printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a preliminary functional test, minimum eight hour burn-in, and computerized final test. The burn-in shall be at 104 °F (40 °C), at full rated load, or cycled load. Drive input power shall be continuously cycled for maximum stress and thermal variation.
2. Optional features shall be functionally tested at the factory for proper operation.
3. Optional features shall be factory mounted, wired, tested and complete with U.L. or ETL listing as an assembled package.

C. Failure Analysis: VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component. The failure analysis lab shall allow the manufacturer to perform complete electrical testing, x-ray components, and decap or delaminate components and analyze failures within the component.

1.6 WARRANTY

A. Description: The VFD shall be warranted by the manufacturer for a period of 36 months from the date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Variable Frequency Drive Controller: Unit shall be a pulse width modulated invertor/controller for scheduled voltage as manufactured by ABB Drives, Inc., or equivalent Eaton Corp., Graham, IDM Controls, Magnatek, Reliance, Saftronics, Toshiba, Westinghouse Danfoss, Square D.

1. Drives shall be PWM. 6-step drives shall not be approved.
2. Drives requiring separate controllers shall be furnished with same.

2.2 VARIABLE FREQUENCY DRIVES

A. General Description: The Variable Frequency Drives (VFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable).
1. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, (enclosures with only NEMA ratings are not acceptable).

a. Environmental operating conditions: 0 to 40° C (32 to 104°F) continuous. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
b. Enclosure shall be UL rated and shall be UL listed as a plenum rated VFD.

2. The VFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device (SCR's, GTO's and Darlington transistors are not acceptable).
3. The drive efficiency shall be 97% or better at full speed and full load.
4. Fundamental power factor shall be 0.98 at all speeds and loads.

B. All VFD's shall have the following standard features:

1. All VFD's shall have the same customer interface, including digital display, keypad and customer connections, regardless of horsepower rating. The keypad is to be used for local control (start/stop, forward/reverse, and speed adjust), for setting all parameters, and for stepping through the displays and menus.
2. The VFD shall give the user the option of either (1) displaying a fault, or (2) running at a programmable preset speed if the input reference (4-20mA or 2-10V) is lost; as selected by the user.
3. The VFD's shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2 line x 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.
5. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs shall count down on the display to warn an operator that a restart will occur.
6. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
8. The customer terminal strip shall be isolated from the line and ground. Provide prewired 3-position Hand-Off-Auto switch and speed potentiometer. When in Hand, the VFD will be started, and the speed will be controlled from the speed potentiometer. When in Off, the VFD will be stopped. When in Auto, the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
9. The drive shall employ three current limit circuits to provide trip free operation:

    a. The Slow Current Regulation limit circuit shall be adjustable to 125% (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
    b. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFD's variable torque current rating.
    c. The Current Switch-off limit shall be fixed at 255% (minimum, instantaneous) of the VFD's variable torque current rating.

10. The overload rating of the drive shall be 110% of its variable torque current rating for 1 minute every 10 minutes, and 140% of its H torque current rating for 2 seconds every 15 seconds.
11. The VFD shall have input line fuses standard in the drive enclosure.

12. The VFD shall have a DC Line Reactor to reduce the harmonics to the power line.
13. The VFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer in ACH 501 units.
14. The VFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.

C. Adjustments: All VFD's shall have the following adjustments:

1. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.
3. Two programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
4. Six programmable digital inputs for maximum flexibility in interfacing with external devices.
5. Two programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power, DC Bus voltage, or Active Reference.
6. Three programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs must be true form C type contacts; open collector outputs are not acceptable.
7. Seven programmable preset speeds.
8. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
9. The VFD shall Ramp or Coast to a stop, as selected by the user.
10. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates.
11. The VFD shall include a fireman's override input. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run at a preset speed or in a separate PID mode.

D. Operation Information Display:

1. The following operating information displays shall be standard on the VFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):
   a. Output Frequency.
   b. Motor Speed (RPM, % or Engineering units).
   c. Motor Current.
   d. Calculated Motor Torque.
   e. Calculated Motor Power.
   f. DC Bus Voltage.
   g. Output Voltage.
   h. Heatsink Temperature.
   i. Analog Input Values.
   j. Keypad Reference Values.
   k. Elapsed Time Meter.
   l. KWH Meter.

E. Protection Circuits: The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).
1. Overcurrent trip 315% instantaneous (225% RMS) of the VFD's variable torque current rating.

2. Overvoltage trip 130% of the VFD's rated voltage.
3. Undervoltage trip 65% of the VFD's rated voltage.
4. Overtemperature +70 ºC (ACH 501); +85 ºC (ACH 502).
5. Ground Fault either running or at start.
6. Adaptable Electronic Motor Overload (I2t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which are not speed dependant are unacceptable.

F. Speed Command Input: Speed Command Input shall be via:

1. Keypad.
2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
   a. Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 Volts.
   b. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.

G. Serial Communications:

1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN and BACnet MS/TP. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet).

H. EMI/RFI Filters: All VFD's shall include EMI/RFI filters. The onboard filters shall allow the entire VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted. No exceptions.

Part 3. - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Contractor shall verify that jobsite conditions for installation meet factory recommended and code required conditions for VFD installation prior to start-up. These shall include as a minimum:

1. Clearance spacing.
2. Temperature, contamination, dust, and moisture of the environment.
3. Separate conduit installation of the motor wiring, power wiring, and control wiring.
4. Installation per the manufacturer's recommendations.

B. Equipment Protection: The VFD shall be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

3.2 INSTALLATION

A. Installation shall be the responsibility of the contractor.

B. Power wiring shall be completed by the contractor, to NEC code 430.122 wiring requirements based on the VFD input current.

C. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.

D. Panel Location: Variable frequency motor control NEMA 1 panel shall be free standing or surface mounted as shown on Drawings.

3.3 START-UP SERVICE

A. Certified factory start-up shall be provided for each drive by a factory authorized service center.

1. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site.
2. Sales personnel and other agents who are not factory certified technicians for drive field repair shall not be acceptable as commissioning agents.

B. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Included in this service, as a minimum, shall be:

1. Verification of Contractor wire terminations to the VFD and its optional circuitry.
2. Installation verification for proper operation and reliability of the VFD, the motor being driven, and the building automation system.
3. Up to one hour of customer operator training on operation and service diagnostics at the time of the equipment commissioning.
4. Measurement for verification of proper operation on each of the following items:

    a. Motor voltage and frequency. Verification of proper motor operation.
    b. Control input for proper building automation system interface and control calibration.
    c. Calibration check for the following set points and adjustments:

        1) Minimum speed.
        2) Maximum speed.
        3) Acceleration and deceleration rates.

END OF SECTION 23 82 23

ELECTRICAL SPECIFICATION INDEX

Part 1. - GENERAL

1.1 SUMMARY

A. General and Supplementary conditions within Division 0 and 1 are hereby incorporated and become part of these Specifications, covering all work in Electrical Division.

B. Before submitting a proposal on the project, the Contractor shall visit the site and familiarize themselves with the conditions and limitations affecting Electrical Division work. No additional costs to the Owner shall be allowed for items verifiable during site visits.

C. Contractor shall provide sufficient workers and materials to keep pace with the construction schedule. Contractor shall place orders for equipment such that job progress is not slowed due to late delivery and shall confirm delivery dates with suppliers.

D. The Contractor shall provide office space and storage for materials and equipment supplied. Location shall be as directed by the General Contractor or the Architect/Engineer.

E. Upon completion of the work shown and specified under Electrical Division and prior to final close out of the Project, the Contractor shall verify in writing that all systems are 100% complete and operating properly. This notification shall include copies of all Subcontractor notifications. Any system not operating properly at final inspection shall be immediately repaired and demonstrated to the Engineer.

F. Rebates or credits provided by utility companies or equipment manufacturers shall be directly credited to the Owner. The Contractor shall identify, coordinate and manage applications for these rebates or credits.

G. The Contractor shall electronically record all training sessions called for within other specification sections and include a copy of each within the Operations and Maintenance Manuals.

1.2 ELECTRICAL PLANS

A. The Electrical Drawings and Specifications shall form a set of Plans for the electrical work. Neither the Drawings nor the Specifications shall be complete without the other. Any item shown on the Drawings or specified in the Specifications shall be considered as shown and specified on both.

B. Any questions regarding the intent of the Drawings or Specifications shall be brought to the Engineer's attention as soon as possible. If direction from the Engineer cannot be obtained due to time or communication limitations, the greater quantity, higher quality or condition most favorable to the Owner shall be assumed. Contractor shall provide all labor, materials, equipment, and miscellaneous items necessary for a complete and operational electrical installation, as shown on the Drawings and called for in these Specifications.

C. Drawings:

1. Contractor shall familiarize themselves with Architectural, Structural and Mechanical Drawings and Specifications. Coordinate all shafts, chases, furred spaces, suspended ceilings, locations of equipment, etc.
2. Electrical Contractor shall coordinate routing of all conduit and wire within soffits provided by the General Contractor. The Electrical Contractor shall provide all soffiting required to cover installations not coordinated or specifically approved by the Architect and Engineer.
3. Electrical Drawings are diagrammatic and are intended to show approximate location only. Placement of electrical equipment and devices shall not interfere with locations or clearances of other trades' materials or equipment. Electrical contractor to coordinate with all trades, suppliers and consultants device locations.

4. Contractor shall verify locations with architectural elevations.
5. Dimensions given on the Drawings shall take precedence over scaled dimensions. Dimensions, whether given in figures or scaled, shall be verified in the field.
6. Contractor shall verify that the equipment to be furnished under Contract will fit within the available space.
7. Notify the Architect or Engineer of any discrepancies between Electrical, Architectural and Mechanical Drawings.
8. Verify items such as door swings, window locations, casework, etc., before installing any electrical equipment or devices. All devices conflicting with other trades work due to lack of coordination shall be relocated at no additional cost to the Owner.

D. The following terms used in the Drawings and Specifications shall be defined as follows:

1. Contractor: Shall mean Electrical Contractor or any of their Subcontractors.
2. Work: Shall mean labor and/or materials of the Electrical Contractor or any of their Subcontractors.
3. Furnish: Shall mean purchase, submit for Engineer approval, coordinate with Contract Documents and deliver to site in a new, undamaged condition.
4. Connect: Shall mean to bring electrical service and/or control wiring to equipment, make all final connections, provide all necessary miscellaneous materials required and do final check out to ensure proper equipment connections.
5. Install: Shall mean to store as directed, protect from damage, set in place, connect, test and turn over to the Owner in full operating condition.
6. Provide: Shall mean furnish and install.

E. Electronic Design Files:

1. Electrical electronic files prepared by Steen Engineering, Inc. for this Project are instruments of Steen Engineering, Inc. for use solely with respect to this Project. During the course of the implementation of the Project, and with Steen Engineering, Inc. approval, copies may be obtained of electronic files for the preparation of Shop Drawings. These electronic files shall not be used on other projects, for additions to this Project, or for completion of this Project by others. Any revisions, additions and/or deletions to these electronic files, either intentional or unintentional, shall be made at the full risk of the person(s) making such revisions, additions and/or deletions. Such person(s) shall hold harmless and indemnify Steen Engineering, Inc. of any and all responsibilities and liabilities.
2. Electronic files of Architectural floor plans, elevations, sections, etc, shall be requested directly from the Architect.

1.3 COORDINATION OF DRAWINGS

A. For typical or repetitive HVAC unit installations, Electrical Contractor shall coordinate with Mechanical Contractor to schedule an inspection with local and/or state AHJ to review a complete mock-up example installation and receive approval prior to proceeding with additional installations. Installation shall meet all code and manufacturer's service clearance requirements. Contractor shall coordinate installation and subsequent inspection with general contractor and any related trades.

B. Contractor shall submit ¼-inch scale drawing to the Engineer indicating placement of all mechanical and electrical systems and equipment. Indicate proposed locations of all major equipment and materials, including but not limited to service equipment, exterior wall and foundation penetrations, fire-rated wall and floor penetrations, sizes and location of required concrete pads and bases, and mechanical/electrical equipment room layouts. This effort will require each trade to closely work together to produce a ¼-inch set of coordination drawings for each area of the building.

C. Coordinate scheduling and sequencing required for movement and positioning of large equipment into the building with all other Contractors to minimize impact on their work.

D. This Contractor shall provide any and all input required to complete these drawings.

1.4 MATERIALS AND EQUIPMENT

A. Materials:

1. All materials shall be new and of the type and quality specified herein.
2. Specific materials and equipment specified is intended to establish a minimum standard of required quality. Where specified materials and equipment fail to meet minimum standards of existing federal, state and local codes and ordinances, the governing codes and ordinances shall prevail.
3. The Contractor shall provide all minor miscellaneous materials necessary for the complete electrical installation.
4. For materials and equipment specified by description only, Contractor shall provide materials or equipment suitable for the purpose intended. These shall be in conformance with all governing codes, these Specifications and normal trade practice.
5. Supply materials and equipment to the site in original packages, containers or crates insofar as is practical. It shall be the Contractor's responsibility to schedule deliveries with other Contractors and the Engineer.
6. Provide for proper receipt, handling, storage and protection from the elements for all materials and equipment to be used on this Project so as to effectively prevent damage or deterioration. Materials or equipment sustaining damage or undue deterioration from any cause whatsoever shall be replaced or repaired by Contractor.
7. The Contractor shall properly protect all equipment from damage during construction. Thoroughly clean all fixtures, equipment and other supplied materials. Make all necessary repairs and apply touch up paint prior to final inspection and contract close out.
8. All materials and equipment shall be listed by Underwriter's Laboratories, Inc. (UL). Materials and Equipment shall meet the UL requirements of each standard in every case where such a standard has been established for that particular type of material. Equipment shall be UL listed and labeled as an entire assembly or system.

B. Prior Approvals:

1. All requests for prior approvals must be received by the Engineer at least seven working days prior to bid date. Applications for prior approval shall be considered only from Contractors submitting bids on the Project. Contractors shall determine whether materials receiving prior approval are actually in accordance with details of the Specifications.
2. The Contractor shall be responsible for all deficiencies that may exist from the use of substituted products and equipment, including additional labor and materials required to complete the work. All dimensions and characteristics of substituted products shall be verified and coordinated with all affected trades and Subcontractors. Any required changes or modifications to the work of any other trade or Subcontractor incurred due to using accepted substituted products shall be coordinated and performed by this Contractor at no additional cost to Owner.

1.5 SUBMITTALS

A. Within fifteen days after the award of the Contract, the Electrical Contractor shall submit shop drawings on all major electrical equipment to the Architect for approval. Shop Drawings shall be submitted by the Electrical Contractor, not their Subcontractors. **Shop drawings shall be submitted separately per specification section. Multiple shop drawing sections received in a single submittal will be rejected.** These shop drawings shall cover such items as lighting fixtures, lamps, disconnects, fuses, starters, MCC sections, switchgear, devices, plates, panels, contactors, etc. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed and dated indicating Contractor review. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis. No equipment shall be released for shipment or installed prior to final approval by the Engineer.

B. The Engineer will review all Shop Drawings submitted and will retain one copy for record file.

C. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required for complete and functional systems. Submittals will be reviewed with the following actions:

1. "No Exception Taken" indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.
2. "Revise per Comments; No Resubmittal Required" indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without an increase in Contract Sum or Time.
3. "Revise and Resubmit" indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
4. "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.
5. "Copy Retained for Record Only" indicates the submittal is retained for reference only and is not reviewed for conformance with the Contract Documents.

D. If the Engineer rejects "Revise and Resubmit" or "Rejected"," the same section two times the engineer shall be compensated for additional reviews. Compensation will be incorporated by Change Order and will be deducted from the Contractor's application for payment. Contractor is responsible for all delays caused by the resubmittal process.

E. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

F. Record Drawings: The Contractor shall provide and maintain an "As Built" set of bluelines on site, neatly notating routing, location or other field changes to the Contract Documents. Upon Project completion and prior to final close out, turn the "As Built" drawings over to the Owner. Provide a detailed transmittal indicating each sheet and other information turned over to the Owner and acquire their representative's signature. This information shall be included at the project close out.

1.6 WORKMANSHIP AND CONSTRUCTION PROCEDURES

A. Installation of all materials specified herein shall be performed in a neat and workmanlike manner by workers experienced and skilled in the trade. Only the best quality workmanship will be accepted.

B. The Contractor shall regularly clean their work area of debris. Removal of all Contractor generated debris and rubbish caused by their work shall be at the Contractor's expense.

C. Contractor shall coordinate with the Owner any interruptions necessary to existing systems prior shut down.

D. Coordination:

1. Contractor shall give careful consideration to work of other Contractors on the Project and shall organize work as detailed in the Contractor's ¼" coordination drawings so as to not interfere with or delay the work of other trades.
2. The Electrical Contractor shall thoroughly review installation manuals for each piece of equipment requiring power and control connections. Obtain instruction manuals from the Mechanical Contractor,

Plumbing Contractor or Owner prior to roughing in any feeders or control wiring. Notify the Engineer of any discrepancies between the electrical plans and specifications and the equipment installation manuals prior to any installation. If for any reason this Contractor fails to do so, any and all costs necessary to correct discrepancies shall be borne by the Electrical Contractor.

3. Contractor shall consult all Architectural, Structural and Mechanical Drawings and Specifications that apply for correlating information.
4. Conflicts or interference with work of other trades shall be brought to the attention of the Engineer, in writing, before installation.
5. Should the Electrical Contractor not follow above procedures and install work that interferes with work of other Contractors, the Electrical Contractor shall make all necessary changes as directed by Engineer to eliminate the interference or conflict at the Electrical Contractor's expense.

E. Protection of Equipment:

1. Until final acceptance of the work by the Owner, the Contractor shall be responsible for the safety, good condition, and protection from damage of all materials and equipment installed.
2. If, during shipment or installation, the finish of equipment becomes chipped or scratched, the Contractor shall touch up or refinish surfaces to match original finish.
3. Switchboards, panelboards, transformers, motor starters and other electrical components stored or installed on-site shall be covered with plywood and polyethylene or an equivalent to protect them from any damage due to site conditions or from work by other trades.

F. The Contractor shall complete all safety forms required by General Contractor.

G. Live Work All electrical equipment shall be de-energized prior to any work being performed. If it is necessary to work on any equipment live due to job conditions, precautions shall be taken to protect authorized personnel from accidentally coming in contact with live parts. Contractor shall have adequate personnel on site along with a back up plan to recover from an unscheduled outage.

1.7 LICENSES, CODES AND FEES

A. The Contractor shall be a licensed Contractor in the State where the project is being constructed. The Contractor shall employ all Licensed Professional Tradesmen required for each type of work covered under these drawings and specifications.

B. The Contractor shall procure all necessary certificates and permits and pay all required fees. The Contractor shall pay all fees and installation charges by the utility company for the permanent services.

C. Codes and Ordinances: All work and materials shall meet the requirements of national, state and local codes and ordinances, in every respect. This requirement shall not relieve the Contractor from meeting the requirements of Drawings and Specifications that may be in excess of all codes and ordinances and not contrary to them. Following is a partial list of governing codes and/or standards:

1. Occupational Safety & Health Act (OSHA)
2. Underwriters Laboratories (UL)
3. State and Local Building Codes
4. State Board of Health
5. State Industrial Commission
6. State and Local Fire Codes and Regulations
7. National Electric Code
8. State and Local Electrical Installation Codes
9. Local Power Company Regulations and Requirements
10. Energy codes

D. Inspections: Regular inspections shall be requested by the Electrical Contractor to meet all state and local requirements. Contractor shall furnish a certificate of final inspection and approval from all enforcement agencies to the Owner.

1.8 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver two sets of Operation and Maintenance (O&M) manuals to the Owner prior to final close out. O&M manuals shall consist of approved shop drawings, manufacturer's bulletins, equipment manuals, a list of manufacturers with telephone numbers for all equipment that contains replaceable parts, training videos and all other data covering the care, maintenance and operation of each piece of furnished equipment. O&M manuals shall be neatly bound in a 3-ring binders, contain an index and section tabs and be labeled with the Project name.

B. Name, address, and telephone number of each Contractor installing equipment and systems, local representative for each item of equipment and each system. Table of contents shall correspond to the Specifications with the Section tab sheets placed before the respective Shop Drawings and operation and maintenance instructions. Warranties for more than 1 year shall be included in appropriate section.

1.9 OPERATING INSTRUCTIONS AND TESTING

A. The Contractor shall fully instruct the Owner in the operation of electrical equipment prior to final close out. Contractor shall provide, without additional expense to Owner, services of competent instructors who will give full instruction in the care, adjustment, operation, and maintenance of all electrical systems provided by this Contractor to Owner's permanent employees. Instructor shall be thoroughly familiar with all parts of the installation that they are to give instructions and shall be trained in operating theory, as well as in practical operation and maintenance work. Factory trained instructors shall be employed wherever they are available. Instruction shall be given during regular work week and at a time just prior to the time the equipment is accepted and turned over to Owner for regular operation.

B. The Contractor or his representative shall provide a minimum of five days instruction period for Owner's personnel.

C. Contractor shall test all equipment installed under this Specification and shall demonstrate its proper operation to the Engineer. No equipment shall be tested or operated for any purpose until it has been fully prepared, connected and made ready for normal operation. Damage to equipment due to improper or ill-timed operation or testing shall be repaired, at Contractor's expense, before final inspection and acceptance.

1.10 WARRANTY

A. The Contractor shall guarantee all materials and equipment to be free of defects that may develop in any part of their work, caused by faulty workmanship, material or equipment failures, for a minimum of one year from the date of final completion of the Project or for as long as normal equipment manufacturer warranties are in effect from the date of Owner acceptance of the Project, whichever is later.

B. During the warranty period, notification by letter, personal contact or telephone conversation of a problem with any electrical system, shall cause the Contractor to respond within one week, making repairs or corrections. After all repairs and corrections are complete, the Contractor shall notify the Engineer.

C. The Contractor shall agree to provide 24 hour service on call for emergency.

1.11 TEMPORARY POWER

A. The Contractor shall provide all necessary temporary power and lighting to allow other Contractors and Subcontractors to perform their work. Prior to submitting a bid for this Project, contact the General Contractor to determine the type of equipment to be used in the performance of the work. The Electrical Bid

shall include all labor and materials required to provide and maintain a complete temporary power and lighting system throughout the course of the project.

Part 2. - PRODUCTS
N/A

Part 3. - EXECUTION

N/A

END OF SECTION 26 00 10

SECTION 26 00 20
ELECTRICAL DEMOLITION

Part 1. – GENERAL

1.1 SUMMARY

A. Contractor shall be responsible for verifying that all existing electrical systems and related equipment under this contract are in proper working order and notify Owner and Engineer of any problems before beginning any new work.

B. Contractor shall verify the condition and functionality of existing systems to which connections will be made, make the connections, and test. Coordinate with the General Contractor for any repairing, finishing and patching work requireed to complete the new systems. Contractor shall leave the electrical system being disconnected in such condition as to allow for an easy, fast and clean reconnection of any new electrical systems.

C. Equipment and materials being removed shall remain the property of the Owner. The Owner shall indicate which items, if any, are to be retained. Items to be salvaged and retained shall be removed, salvaged, cleaned and placed in a storage area designated by the Owner. All other material and equipment not wanted by the Owner shall be removed from the site and disposed of properly.

D. Accomplish all demolition using only electricians skilled in the trade. If necessary, subcontract the work to meet this standard. If subcontracting is required, schedule the work to avoid delays or interruptions.

E. Schedule work in cooperation with the Owner's representatives to avoid disturbance or interruptions of the Owner's services and functions. Provide off-hours work or phasing of the project to meet this requirement.

F. The Engineer has performed a field survey to ascertain existing site conditions. This survey was visual only and no attempt was made to verify exact conduit routing above ceilings or in walls. The Contractor shall thoroughly review demolition and construction Drawings and Specifications and be fully aware of design intent. Additional work required due to deviations found after ceilings and walls are opened up shall be performed at no additional cost to the Owner.

G. Contractor shall notify Engineer immediately upon discovering any electrical equipment not shown on the Drawings that result in site conflicts.

H. Help call, telephone, television and fire alarm systems, etc. shall remain in full operating condition during the entire construction period. Should any portion of any system require relocation or demolition, this Contractor shall schedule the work with the Owner and system representative 48 hours prior to performing the actual work.

I. Existing wiring and equipment:

1. All existing wiring, fixtures and equipment shall remain as is, except where removal is called for on the Drawings and/or in the Specifications or made necessary by the alterations to the building as part of this contract.
2. All conduit and wiring uncovered by other contractors within the existing building walls, floors or structure shall be replaced or rerouted as necessary to complete the remodeling (i.e., where the General Contractor removes a wall or floor, or cuts an opening into a wall or floor, any conduit uncovered shall be rerouted by the Electrical Contractor at no additional cost to the Owner). Wherever it is necessary to withdraw conductors from existing raceways, new conductors shall be installed.
3. All existing work altered during the course of remodeling shall be placed in safe operating condition, shall remain in service unless otherwise noted, and shall be restored to satisfactory operating condition.

Part 2. – PRODUCTS

N/A

Part 3. – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Carefully handle all fixtures and devices being removed. Properly store items scheduled for reinstallation. If the Contractor fails to properly protect items scheduled for reuse, it shall be the Contractor's responsibility to furnish new items, equal to the existing, at no cost to the Owner.

B. Contractor shall properly dispose of all lamps and all fixture ballasts not reused in new construction. Remove all lamps and ballasts from the site and dispose with a state certified disposal facility.

C. Where branch circuit or feeder conduits are stubbed out of a column or slab and will not be reused, cut back to a point below the finished surface and patch to match existing.

D. Daily clean all work areas to minimize dirt and dust in the facility.

E. Wherever an existing device is removed, Contractor shall provide conduit and wiring to maintain service to all remaining devices.

F. Wherever switches, receptacles, lighting fixtures and other electrical components are removed from boxes that remain in walls or ceilings, provide blank coverplates. Where clocks or speakers are removed, provide coverplates to cover entire opening.

G. Wherever existing panels are modified, provide revised typed directories, identifying all circuits with clear plastic cover mounted in card holder. Room numbers or names used for circuit identification shall correspond to nameplates installed on room doors by General Contractor or as selected by Owner. If panel does not have a panel identification, provide a label per Section 26 24 16.10.

END OF SECTION 26 00 20

SECTION 26 00 50
BASIC MATERIALS AND METHODS

Part 1. - GENERAL

1.1 GENERAL REQUIREMENTS

A. Unless noted otherwise in this Specification or on the Drawings, all materials shall be new and in their original packages. All materials shall comply with this Specification and at a minimum all applicable codes and standards as listed in Section 26 00 10.

B. Nameplates shall identify equipment by name. They shall be micarta plates, minimum of 1 1/4" x 3", or larger if necessary for wording with 3/8-inch high white lettering.

C. All distribution equipment, such as disconnects, starters, panels and switchgear, shall be obtained from one manufacturer.

D. The Contractor shall be responsible for verifying locations of such things as piping, ductwork, equipment, door swings, heights of cabinets and counters, etc., prior to the installation of all electrical equipment. Installed electrical work that interferes with the work of other trades shall be relocated by the Electrical Contractor at no additional cost to the Owner.

E. Contractor shall paint all exposed electrical equipment, such as conduit/raceway, meter sockets and panels, to match adjacent finishes. Refer to Architectural Specifications for method to be used.

F. Switched receptacles, where shown, shall be modified and connected so that only the upper portion is switched.

G. Receptacles and outlets located on opposite sides of a common wall shall not be mounted in the same stud space. At least one stud shall separate devices. Where this requirement is not practical, such as in back to back floor plans where devices must be back to back, the use of 3M MPP-4S moldable Puddy Pad shall be used in sufficient thickness to match the hour rating of the wall. Coordinate with the general contractor.

H. All switches, receptacles and outlets installed within rated assemblies shall be firestopped to maintain rating of assemblies.

I. Circuit numbers shown are for reference only within noted panel. Contractor shall neatly identify correct circuit numbers on the as-built drawings.

J. Where required by code, the Contractor shall provide GFI devices or GFI breakers per the NEC.

K. Provide AFI breakers for all 125 volt, single phase branch circuits in all units, except for bathrooms, garages and unfinished basements. Follow the NEC and local amendments.

Part 2. - PRODUCTS

N/A

Part 3. - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Provide nameplates on all equipment such as disconnects, starters, panels and switchgear.

B. Identify all pull and junction boxes with circuit or feeder numbers and source of power using black magic marker.

C. Each panelboard shall be provided with a typed circuit directory. Clearly describe loads and areas served. Room names or Owner's room numbers shall be used. Handwritten directories will not be accepted.

D. The Contractor shall perform saw cutting, trenching, backfilling, compaction and patching required for underground raceway systems shown or specified.

E. The Contractor shall provide concrete pads for all floor mounted equipment. Pads shall be 4" thick and extend a minimum of 2" beyond equipment.

F. Contractor shall verify the location of all fixtures and devices with the Architect prior to installation.

G. Provide access panels where j-boxes or pull boxes are installed in inaccessible locations. All access panels shall be approved by the Engineer and Architect prior to installation.

H. Contractor shall provide matching cord and plug for all dishwashers, disposals, ranges and electric dryers, unless provided with equipment. Provide matching receptacles. Coordinate with equipment supplier.

I. In handicapped living areas, controls or switches for range hoods, disposals, undercabinet fixtures, etc. shall be installed in the kitchen cabinet face.
All receptacles and outlets located in block walls shall be mounted so that only one block is cut.

J. Contractor shall connect all exterior and vestibule lighting circuits through timeclock/photo control/lighting contactor for control.

K. Contractor shall submit all fire stopping methods to the local authorities for approval. Provide copies of all approved fire stopping methods to the Engineer. All fire stopping shall be reviewed and approved by Local Authorities prior to installation.

END OF SECTION 26 00 50

Part 1. – GENERAL

1.1 SUMMARY

A. Section Includes: Excavating, backfilling and compaction of all earth required for proper installation of buried electrical material, wherever required by the Drawings and Specifications.

1.2 EXCAVATION AND BACKFILLING

A. General Requirements: Contractor shall perform excavation, backfilling, and compaction for installation of electrical work within earth, including conduit and direct burial cables, as well as ducts or manholes shown on Drawings, as follows:

1. All conduit and direct buried cable shall be installed a minimum of twenty-four inches below finished grade. Trench shall be graded level to provide uniform support for each section of conduit. Excess excavation below required level shall be backfilled and compacted to 98% prior to conduit or direct buried cable installation. All debris and water shall be removed from the trench prior to final installation of conduit or direct buried cable. Properly protect conduit or direct buried cable until backfilling can be performed.
2. After underground lines have been inspected and prior to backfilling, forms shall be removed and excavation shall be cleaned of trash, debris and water. Material for backfilling shall consist of excavation, or borrow of sand, gravel or other materials approved by Engineer, and shall be free of trash, lumber or other debris. Place backfill in horizontal layers, not exceeding six inches in thickness, and properly moisten to approximate optimum requirements. Each layer shall be compacted down by hand or machine tampers, or by other suitable equipment, to a density that will prevent excessive settlement or shrinkage. Backfill shall be brought to a suitable elevation above grade to provide for anticipated settlement and shrinkage.
3. Underground electrical lines exterior to building are to be marked by installation of a continuous identifying tape buried in trench above line. Bury tape six inches below finished grade. Tape shall be made of inert plastic, six inches wide, yellow or orange colored with the words “Caution Buried Electric Line Below” repeatedly printed along length of tape. Type shall be Griffolyn Company, “Terratape”.

B. Inspection of all installations by local inspection authorities shall be completed prior to backfilling. Restore surface to its original condition, ie grass, concrete, blacktop, etc.

C. Areas on Owner’s property backfilled by electric utility, for electric services to building, shall be compacted and brought up to suitable grade by Contractor.

D. Areas directly under sidewalks and roadways shall be compacted to a dry density no less than 95% of ASTM D1557 moisture density relationship. Contractor shall pay costs for testing of compacted backfill by an approved testing laboratory when tests are requested by Architect/Engineer.

E. Dewatering:

1. General: Maintain excavated areas in a dry condition during excavation, compaction and backfilling operations. Under no circumstances shall concrete be poured under water. Perform excavation in a manner to prevent surface water and subsurface or groundwater from flowing into excavations. Do not allow water to accumulate in excavations.
2. Method: Remove water from excavations using dewatering methods to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge lines and other dewatering system components necessary to convey water away from excavations. Convey water removed from

excavations and rain water to collecting or run-off areas. Provide and maintain temporary drainage ditches or other diversions outside excavation limits. Do not use trench excavations for site utilities as temporary drainage ditches.

1.3 EQUIPMENT PADS

A. Contractor shall provide equipment pads for all exterior electrical components furnished under this contract and for the electrical utility transformer(s). Pads shall extend a minimum of six inches beyond the physical dimensions of the equipment and shall be a minimum of six inches deep. Provide all excavation, soil removal from site, compaction, forms and forming reinforcing steel, 3000 psi concrete and finishing, minor concrete touch up, removal of forms and backfilling to properly support equipment. Construct utility transformer pads per utility company requirements including all steel or PVC stubouts for primary and secondary conductors' installation. Provide grounding system.

1.4 POLE BASES

A. Contractor shall provide all excavation, soil removal from site, forms and forming, reinforcing steel 4000 psi concrete, and finishing, anchor bolts, conduit stubouts, minor concrete touch up removal of forms and backfilling for a complete support base for all exterior fixtures as shown or specified. Bases shall be sized as called for on the details. Any question as to the size, depth or finished elevation of any bases shall be brought to the Engineer prior to setting any forms or pouring any concrete. Match existing site footings and installation.

Part 2. – PRODUCTS

N/A

Part 3. – EXECUTION

N/A

END OF SECTION 26 04 00

Part 1. – GENERAL

1.1 GENERAL REQUIREMENTS

A. The Contractor shall be responsible for all cutting, drilling, removal, patching and refinishing of walls, ceilings, roofs and floors to provide a complete electrical system as shown on the Drawings and as called for in these Specifications.

B. All cutting and patching shall be done with the prior approval of the Architect/Engineer. Patching to match existing finishes shall be performed by the proper trades such as concrete finishers, sheetrockers, tapers, painters, etc.

Part 2. - PRODUCTS

N/A

Part 3. – EXECUTION

3.1 CUTTING, DRILLING AND PATCHING

A. All holes in masonry or concrete shall be drilled by use of a core drill.

B. Cutting: Chases and trenches required for the installation of electrical raceways and/or other electrical apparatus shall be saw cut prior to removal of existing materials. All cutting shall be straight and level.

C. Drilling: Impact rotary hammers shall not be used. Approval shall be obtained from the Architect and Structural Engineer prior to performing any core drilling. Upon completion of installation, seal excess openings with non-shrinking grout or compound.

D. Sleeves: Wall and floor sleeves required for electrical work shall be provided by this Contractor. Adequate fastening arrangements shall be employed in setting sleeves and checked during pours to ensure proper positioning. Floor sleeves shall project a minimum of 1-inch above the floor surface. Upon completion of the installation, Contractor shall provide a fire rated material to maintain fire rating of wall or floor.

E. Patching: All surfaces disturbed during installation of the electrical system shall be fully restored to their original condition. Patching shall be performed by workers experienced, skilled, and licensed for that particular type of work involved. Inferior work will not be accepted. Roof patching shall be weather tight.

F. Grouting: Contractor shall be responsible for grouting airtight, openings adjacent to raceways and other electrical openings to seal against passage of air, smoke, or vapors. Openings around raceways through floors shall be sealed watertight. Maintain ratings of fire rated partitions.

END OF SECTION 26 04 30

SECTION 26 05 10

ELECTRICAL CONNECTIONS

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide circuits, including final connections unless noted otherwise, to each item of electrically powered equipment wherever required by the Drawings and Specifications.

1.2 SUBMITTALS

N/A

1.3 CONNECTIONS

A. Connect all equipment per instruction manuals provided by the Mechanical Contractor, Plumbing Contractor or Owner as specified in Section 26 00 10.

B. Connect all equipment as indicated in the Mechanical and Electrical Equipment Schedule and as specified in Section 26 24 19.

C. Kitchen Equipment: Connect as called for in the Kitchen Equipment Schedule. Equipment locations, conduit rough-ins and dimensions shall be obtained from the kitchen equipment suppliers' Contract Drawings and Shop Drawings prior to conduit installation. Refer to the kitchen designers' drawings for all rough-in's and electrical characteristics.

D. Do not scale Electrical Drawings for rough-in dimensions.

Part 2. - PRODUCTS

N/A

Part 3. - EXECUTION

N/A

END OF SECTION 26 05 10

SECTION 26 05 19.10
WIRE AND CABLE
(600 VOLTS AND BELOW)

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide and connect 600 volt and below wire and cable.

B. Wiring Sizing**:** Wire sizes indicated on Drawings are for copper conductors. Conductor sizes are specified by American Wire Gage (AWG) numbers, except where conductor cross sections in Kcmil is indicated. Unless noted otherwise conductors smaller than 12 AWG shall not be used for branch circuits.

C. In Conduit**:** Unless otherwise noted on Drawings, electric system conductors shall be installed in conduit. Conduit fill requirements of the National Electric Code (NEC) shall not be exceeded.

D. MC Cable: MC Cable may be used where permitted by local Code.

1.2 QUALITY ASSURANCE

A. Underwriters' Laboratories (UL): Devices shall be in accordance with Section 26 00 10.

1.3 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

1.4 CONDUCTORS FOR COMMUNICATION AND OTHER SYSTEMS

A. General Requirements: Refer to specific communication system Sections for conductor requirements.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All wire and cable and accessories shall be as follows:

1. Building Wire/Cable: Recognized manufactures of electrical building wire.
2. Plastic Tape: AMP, Eagle or 3M.
3. Spring Wire Connectors: Heyco, Ideal, 3M or T&B.
4. Split-Bolt Connectors: Burndy, O-Z/Gedney, Square D, or T&B.
5. Solderless Crimp Pressure Connectors: Burndy, Ideal T&B or 3M.
6. Twist-on Wire Connectors: Buchanan, Ideal or 3M.
7. Vinyl Electric Insulation Tape: Permacel, Tomic or 3M.

2.2 CONDUCTORS

A. Copper Conductors: Conductors shall be soft, annealed 98% copper, electrically continuous and free from short circuits or grounds.

B. Aluminum Conductors: Aluminum conductors may be substituted for No. 2 AWG or larger copper conductors where both conductors and conduit sizes are increased over those shown on Drawings to provide equal or

greater ampacities in accordance with the NEC. No aluminum conductors shall be directly buried in earth. The use of all aluminum conductors shall be approved by the Local Code Authorities.

C. The Electrical Contractor shall thoroughly review installation manuals for each piece of equipment containing VFDs. Obtain instruction manuals from the Mechanical Contractor, Plumbing Contractor or Owner prior to roughing in any feeders. Notify Engineer of any discrepancies between the electrical plans and specifications and the equipment installation manuals prior to any installation. If for any reason this Contractor fails to do so, any and all costs necessary to correct discrepancies shall be borne by the Electrical Contractor.

D. Aluminum conductors shall not be used in lieu of copper for elevator feeders.

2.3 SOLID AND STRANDED

A. General Requirements:

1. Wires shall be solid for sizes 10 AWG and smaller.
2. Wires shall be stranded for sizes 8 AWG and larger.

2.4 INSULATION

A. Voltage Class: Insulation, unless otherwise noted, shall be 600 volt.

B. Insulation Type: Conductor insulation shall be as follows:

1. Service, Feeder, and Branch Circuit Conductors: Type THHN/THWN with a temperature rating of 75°C. 75°C M/C cable (where allowed per Code) within insulated areas.
2. Direct Burial Conductors: As noted on Drawings. Type USE or UF cross-linked polyethylene.

C. Color Code: Wire and cable color shall be in accordance with the latest edition of the NEC. On larger cables, only where factory coloring is not available, marking tape shall be used to identify each phase and neutral conductors. A minimum length of six inches shall be color coded at each end.

2.5 CONNECTORS AND TERMINATIONS

A. Conductors 8 AWG and Smaller**:** Use solderless crimp or indent type pressure connectors with insulating covers for copper wire splices and taps for 8 AWG. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps. Strictly comply with the number, size and combination of conductors as listed on manufacturer's packaging.

B. Conductors 6 AWG and Larger**:** Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape.

2.6 CONTROL WIRING

A. General Requirements:
1. Control conductors shall be 12 AWG or larger.
2. Conductors shall be sized large enough so that voltage drop under in-rush conditions will not adversely affect operation of controls.

Part 3. - EXECUTION

3.1 GENERAL WIRING METHODS

A. General Requirements:
1. Provide 12 AWG or larger conductors for power and lighting circuits and no wire smaller than 14 AWG for control wiring.
2. Provide 10 AWG conductors for 20 ampere, 120 volt branch circuit runs longer than 75 feet and for 20 ampere.
3. Place an equal number of conductors for each phase of a circuit in same raceway or cable.
4. Conductors shall be tested to be continuous and free from shorts and grounds.
5. Neatly train and lace wiring inside boxes, equipment, and panelboards.
6. Conductor lengths for parallel circuits shall be equal.
7. Provide a minimum of twelve inches of slack conductor at each outlet.
8. Cables shall not come into direct contact with any mechanical systems, such as sprinkler piping, plumbing piping, ductwork, etc.

3.2 WIRING INSTALLATION IN RACEWAYS

A. General Requirements:

1. Pull all conductors into a raceway at the same time. Use Underwriters' Laboratories (UL) listed wire pulling lubricant for pulling No. 4 AWG and larger wires.
2. Completely and thoroughly swab raceway system before installing conductors.
3. Control and communication conductors shall be installed in separate, dedicated raceway systems.

3.3 INSTALLATION OF ALUMINUM CONDUCTORS

A. When Permitted: Contractor shall substitute aluminum conductors for copper, only when permitted in Article 2.2 of this Section and only in sizes specified.

B. Installation: Aluminum conductors shall be installed in accordance with Aluminum Building Wire Installation Manual and Design Guide as published by Aluminum Association.

C. Vibration Precaution: No aluminum conductors shall be connected directly to motors, air conditioners or any equipment that vibrates. At these locations, aluminum conductors shall terminate in safety switches or junction boxes near units with copper conductors extended, in flexible conduit, directly to motors.

3.4 WIRING CONNECTIONS AND TERMINATIONS

A. General Requirements:

1. Splices shall only occur in accessible junction boxes. Splices in conductors installed below grade are not permitted.
2. Wires shall be thoroughly cleaned prior to installing lugs and connectors.
3. Splices, taps and terminations shall be made to carry full ampacity of conductors without perceptible temperature rise.
4. Spare conductors shall be terminated with electrical tape.

END OF SECTION 26 05 19.10

SECTION 26 05 26
GROUNDING SYSTEM

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide labor, materials, equipment and accessories for the following Work:

1. Electric Service Ground: Provide grounding of secondary service neutrals at the supply side of the service disconnecting means in accordance with the National Electric Code (NEC).

    a. Provide grounding of the metallic conduit system, cabinets, non-current carrying parts of equipment and neutral service conductor at the service entrance.

2. Equipment Ground: Provide solid interconnections to form a continuous permanent and effective equipment grounding medium between the entire conduit system, switch boxes, cabinets, motor frames and other permanently installed electrical equipment:

    a. Feeder and Branch Circuits: Provide an insulated grounding conductor, sized per the NEC.

        1) All EMT conduits 1 1/2 inches and larger
        2) All PVC conduits
        3) All flexible metal conduits

    b. Switchboard Grounding: Terminate conduits entering the switchboard in grounding bushings bonded to switchboard ground bus.

3. Metal Piping: Bond interior metal piping systems to the services equipment enclosure, the grounded conductor at the service or to the grounding electrode conductor.
4. Dry Type Transformers: Provide grounding for each dry transformer for separate derived systems in the NEC. Coordinate with elevator supplier if a buck boost transformer is required. Ground per NEC 250.
5. Communication System Grounding: Provide grounding for each communication system.
6. Concrete Encased Electrode: Provide 20’ grounding electrode conductor connected to bar or rod, encased in concrete, per NEC 250. Coordinate with structural.
7. Gas Meters: Provide continuous ground conductor between each metallic pipe connection to building service ground rod per NEC 250. Refer to detail.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Provide grounding systems to comply with the requirements of the NEC. Coordinate with the local electrical inspector.

B. Tests: Measure ground grid resistance with earth test megger. Provide additional ground rods and conductors until resistance to ground meets NEC and local code requirements.

1.3 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

Part 2. - PRODUCTS

2.1 MATERIALS

A. Grounding System: Except as otherwise indicated, provide electrical grounding systems with assembly of materials including, but not limited to, cables/wires, connectors, terminals, grounding rods/electrodes, bonding jumpers, and additional accessories needed for complete installation. Where materials or components are not indicated, provide products meeting the requirements of NEC, UL, IEEE, and established industry standards for applications indicated.

1. Conductors: Copper cable, stranded of size per the NEC unless otherwise noted on Drawings.
2. Bonding Jumper Braid: Copper braided tape, constructed of 30 gauge bare copper wires and properly sized for indicated applications.
3. Connectors, Terminals, and Clamps: Burdy, Kearney, T & B, Penn-Union.
4. Ground Rods: Copper clad steel, ¾-inch diameter, a minimum 10 feet in length.

Part 3. - EXECUTION

3.1 INSTALLATION

A. General Requirements: Grounding and bonding shall comply with the requirements of the NEC and shall be coordinated with the local electrical inspector. This, however, shall not be construed as relieving the Contractor from meeting any requirements of the Drawings and Specifications that may exceed code requirements.

3.2 GROUNDING ELECTRODE

A. General Requirements: Grounding electrode shall be the metal water piping system of the building. Water piping system electrode shall be supplemented by the following additional electrodes:

1. Metal Frame of Building: Metal frame of building in those buildings with a metal frame system.
2. Made Electrode: Provide at least 20 feet of bare copper conductor not smaller than No. 4 AWG or at least 20 feet of one or more steel reinforcing rods encased by at least 2 inches of concrete located within or near bottom of a concrete foundation or footing that is in direct contact with earth. A ground rod electrode system may be provided in lieu of foundation electrode where approved by the local electrical inspector.

3.3 GROUNDING ELECTRODE CONDUCTOR

A. Service Grounding: Grounding electrode conductor, from service entrance to grounding electrode, shall be an exposed insulated copper conductor run. Where NEC or the local electrical inspector requires grounding electrode conductor run in conduit, provide rigid non-metallic type, conduit.

1. Connection of ground electrode conductor shall be made at the point water piping system enters building. Connection to piping system may be permitted at locations other than entry to building, provided Contractor coordinates location with the local electrical inspector and provides bonding jumpers around meters, insulating joints, and other electrical components. Connections of ground electrode conductor to water main or other large members shall be made by means of approved pressure clamps.

3.4 MAIN BONDING JUMPER

A. General Requirements: Connect secondary service neutral and grounding electrode conductor to equipment grounding bus in service equipment.

3.5 FEEDER AND BRANCH CIRCUITS

A. General Requirements: Provide an insulated grounding conductor, sized in accordance with the NEC, within all PVC conduits, within all flexible metallic conduits and within all EMT conduits 1 1/2 inches in diameter or larger.

3.6 CONDUITS, BOXES, CABINETS AND PANELBOARDS

A. General Requirements:

1. Ground all metallic conduit systems. Establish ground continuity by providing standard couplings, connectors, fittings and jumpers at all grounding type wiring devices, motor and ground terminals.
2. Ground wires shall be grounded to each pull box, junction box, outlet box, cabinets and other enclosures through which the ground wires pass, except for special isolated grounding systems.
3. Provide lugs in each box and enclosure for ground wire termination where required.

3.7 DRY TRANSFORMER GROUNDING

A. General Requirements: Ground each transformer secondary at transformer, at first disconnecting means to building metal frame or at the cold water piping system using a copper conductor sized in accordance with the NEC. Bond the transformer housing, secondary disconnect housing and conduits to this grounding system.

3.8 TRANSFORMER PAD GROUNDING

A. General Requirements: Provide four copperweld 5/8-inch diameter ground rods driven at four corners of concrete pad a minimum 18 inches away from pad. Ground rods shall be bonded together with a No. 1/0 bare copper conductor buried 6 inches below grade and extending 5 feet into transformer enclosure for connection to ground lug. Verify above grounding procedure with the requirements of the local power company prior to installation.

3.9 MISCELLANEOUS EQUIPMENT

A. Motors and Starters: Provide lugs in motor terminal boxes and starter housings for ground wire termination and provide interconnecting ground wire.

B. Receptacles: Provide a ground wire from receptacle green ground terminals to outlet box ground screws.

C. Lighting Fixtures: Provide grounding through conduit systems. Provide a green ground wire with power wires from fixture through flexible conduit to first outlet box for all fixtures connected with flexible conduit.

D. Electrical Equipment: Provide a ground lug for termination of green ground conductor for all fixed electrical equipment.

E. Pools, spas, therapy tubs and fountains: Provide bonding and grounding per NEC. Coordinate with AHJ.

F. In areas used for patient care, the grounding terminal of all receptacle and all non-current carrying conductive surface of fixed electrical equipment likely to become energized shall be grounded by a green insulated copper conductor. The grounding conductor shall be sized per NEC and installed in EMT with the branch circuit conductors supplying these receptacles or fixed equipment.

3.10 COMMUNICATION GROUNDING

A. General Requirements:

1. Provide grounding at telephone and CATV backboards.
   a. Data Communication System(s)
   b. Fire Alarm Control Panel
   c. Intercommunication
   e. Sound System(s)
   f. Telephone System
   g. Television Distribution System

3.11 LIGHT POLE GROUNDING

A. General Requirements: Provide an equipment grounding conductor, with green insulation, with circuit conductors to each pole. Connect grounding conductor to ground lug at pole.

END OF SECTION 26 05 26

SECTION 26 05 33.10
CONDUITS AND FITTINGS

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide conduits wherever required by the Drawings and Specifications.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 0010.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Steel Conduit and Fittings: Galvanized steel by recognized manufacturers of conduit systems of type and sizes required.

B. Non-Metallic Conduit: High impact PVC (Polyvinyl Chloride) heavy wall, Schedule 40 rated for 90° C wire, Underwriters' Laboratories (UL) listed in accordance with Article 347 of the National Electric Code (NEC) for underground and exposed use. PVC conduit shall be Schedule 80 for under roadway or vehicle crossing area.

C. Acceptable Manufacturers: All conduit shall be of one manufacturer as follows:

1. Alfex
2. Allied
3. Carlon
4. Republic
5. Sealtight
6. Triangle
7. VAW of America
8. Youngstown

D. Acceptable Manufacturers: All conduit fittings shall be of one manufacturer as follows:

1. Appleton
2. CH
3. Kellems
4. OZ Red Dot
5. T&B

2.2 CONDUITS

A. Minimum Size: Conduit shall be sized according to the Drawings, with no conduit smaller than ½-inch trade size. If not sized on the Drawings, the NEC shall be used to determine the size based on the number and size of conductors required. The Engineer shall approve all calculated conduit sizes and method of installation prior to installation.

B. Type: Conduit shall be rigid galvanized steel. In lieu of rigid galvanized steel the following conduits may be used only as specified herein:

1. Intermediate Steel Conduit may be used in all locations.
2. Electric Metallic Tubing (EMT): May be used in dry locations for wiring below 600 volts in all interior spaces not in direct contact with earth or where exposed to weather using steel watertight compression fittings and backstraps. EMT shall not be installed in the following areas:

    a. Concrete slabs on grade or in soil.
    b. Unprotected within five feet of finished floor.
    c. Conduit drops in shop areas.
    d. Conduit stub-ups to equipment or machinery.
    e. Hazardous areas.

3. Flexible Metal Conduit: Flexible metal conduit or liquid tight flexible metal conduit shall be permitted only in the following locations:

    a. Flexible metal conduit or liquid tight flexible metal conduit shall be used for final connections to equipment such as motors, fixed equipment, electric heating equipment, etc. Trade sizes ½-inch through 1 ½-inch shall be used in lengths no longer than twenty-four inches, 2-inches through 3-inches no longer than thirty-six inches, 3 ½-inch through 4-inch no longer than forty-eight inches.
    b. Fittings shall be steel set screw type for smaller sizes and steel clamp type for larger sizes.
    c. For light fixture connections, where conduit is concealed above ceilings, lengths shall not exceed six feet (3/8-inch diameter size may be used above concealed ceilings to connect light fixtures).
    d. Concealed within equipment cabinets if approved by Architect/Engineer.

4. Rigid Non-Metallic Conduit: May be used only where run in soil or in concrete slabs on grade unless otherwise noted on Drawings or specified herein.

    a. Conduit entries into pole bases or concrete pads shall be rigid galvanized steel. Conduits emerging out of floor slab-on-grade shall be rigid galvanized steel.
    b. All non-metallic conduits shall have a grounding conductor sized in accordance with Table 250-95 of the NEC. Contractor shall increase conduit size to accommodate the grounding conductor.

5. Rigid Aluminum Conduit: May be used in lieu of rigid galvanized steel with approval of Engineer.

2.3 CONDUIT FITTINGS

A. Rigid Galvanized Steel Conduit and Intermediate Metal Conduit:

1. Couplings, locknuts and bushings shall be threaded type. Threadless couplings shall not be used without prior approval of Engineer.
2. Locknuts shall be of the conduit type.
3. Bushings shall consist of an insulating insert molded or locked into metallic body fitting. Bushings made entirely of metal or non-metallic material are not permitted.
4. Where conduit is installed in concrete, Erickson-type and set-screw couplings may be used to complete a conduit run. Set-screw fittings shall be approved for concrete installation and shall be case-hardened steel with hex head and cup point to firmly set in conduit wall for positive ground.
5. Threaded cast iron type sealing fittings shall be used. Fittings used to prevent passage of water vapor shall be continuous drain type. Fittings in concealed work shall be installed in a flush steel box with blank coverplate having the same finish as that of other electrical plates in room.

B. EMT:

1. For conduit 2-inch and smaller, fittings shall be concrete tight compression gland type only, with threaded outer nut or set-screw type. Fittings shall be malleable steel type, not cast.
2. For conduit over 2-inch, connectors shall be set-screw type with two screws each and couplings shall be

set-screw type with four screws each. Set-screws shall be case-hardened steel with hex head and cup point to firmly set in wall of conduit for positive ground.

3. Indent type connectors shall not be permitted.
4. Fittings made of pot metal die cast or pressure-cast zinc alloy shall not be permitted.

C. Flexible Metal: Multiple point type threading into internal wall of conduit convolutions or set-screw type. Material shall be only steel or malleable iron.

D. Liquid-Tight Flexible Metal: Type incorporating a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats. Material shall be only steel or malleable iron.

E. Direct Burial Rigid Non-Metallic Conduit: Fittings as recommended by conduit manufacturer for bonding with solvent cement. Provide PVC-40 in all landscape areas and PVC-80 under all covered areas where vehicles travel.

F. Expansion Fittings: Use expansion fittings in conduits installed in concrete slabs or in soil under slabs at the point where conduits cross expansion joints. Verify expansion joint locations with concrete installer. Expansion fittings shall be O.Z. Type AX for rigid conduit, O.Z. Gedney Type TX for EMT conduit and Carlon Type E945 for rigid non-metallic conduit. All rigid non-metallic conduits installed at a temperature of 25° F above or below the final conduit temperature, as well as all rigid non-metallic conduits installed in temperatures below 50° F, shall require expansion fittings. Where temperature conditions require the use of rigid non-metallic expansion fittings, provide one expansion fitting for each conduit run up to one-hundred feet long. Runs over one-hundred feet in length require one expansion fitting for each one-hundred feet or portion thereof.

2.4 FIRE STOPS

A. General Requirements: Conduits and conduit sleeves that penetrate fire rated walls or partitions shall be sealed with Hevi-Duty/Nelson, Type CLK, non-sagging adhesive sealant. Basis of design is Hevi-Duty/Nelson, Type CLK. Additional approved manufactures are 3M and Specified Technologies Inc. All firestopping products shall be installed by experienced workers familiar with the proper application and installation of appropriate U.L fire stopping design rating systems. Prior to installation, the Contractor shall submit fire stopping manufacturer's appropriate conduit and conduit sleeve penetration system design criteria and UL approved number for each type of UL fire stopping design rating system used on the project.

Part 3. - EXECUTION

3.1 CONDUIT ARRANGEMENT AND SUPPORT

A. General Requirements:

1. Conduits shall be concealed within floor, ceiling or wall building construction, unless specifically noted or otherwise specified. Conduits shall only be installed exposed in boiler rooms, mechanical rooms and electric rooms and for connections at motors and surface cabinets.
2. Conduit systems shall be complete with fittings and accessories to make the system complete and electrically continuous from outlet to outlet and to cabinets and junction boxes. Conduits shall form a neat appearance, mechanically firm assembly, adhering to NECA standards of installation and good electrical practice. Conduit ends shall be reamed before installation and shall be capped during construction period. Route exposed conduits and conduits above accessible ceilings parallel and perpendicular to walls and adjacent piping with elbows, offsets, and bends uniform and symmetrical.
3. Conduits shall not obstruct headroom, walkways, or doorways.
4. Conduits shall be secured to cabinets, junction boxes, pull boxes and outlet boxes by bonding type locknuts. Rigid and IMC conduit installations shall have a locknut on the outside of enclosure and EMT installations may have a single locknut on the inside of enclosure, wrench tight. Conduit connections shall not be made to junction box covers.
5. Provide a pull wire in empty conduits, consisting of one No. 12 steel or copper wire or heavy-duty nylon

cord for small conduits and nylon rope for large conduits.

6. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Conduit shall be fastened using straps or clamps, lay-in adjustable hangers, clevis hangers or bolted split galvanized hangers secured to structure with machine screws, expansion sleeves or lead anchors. Spring steel type supports or fasteners shall be permitted for concealed 1/2-inch EMT only. Chain, wire or perforated straps shall not be used to support or fasten conduit.
7. Conduit support spacing shall be provided per Code, but in no case shall the maximum spacing of supports exceed six feet for conduits smaller than 1-inch trade size and 10 feet for conduits 1-inch trade size and larger.
8. Group conduits in parallel runs where practical using conduit racks constructed of steel channel with conduit straps/clamps or trapeze hangers with U-bolts or other approved fasteners.
9. Conduits that are direct buried in the same trench shall be group in parallel runs where practical. The conduits shall be installed using racks or supports to maintain air separation between all conduits as per NEC at a minimum.
10. Fasteners shall be sized and designed for intended use. Fasteners, in solid masonry or concrete, shall be steel or malleable iron concrete inserts, 1/4-inch minimum diameter steel expansion anchors embedded not less than 1 1/8-inches or 1/4-inch minimum diameter power set fasteners with depth of penetration at least three inches. Hollow masonry anchors shall be toggle bolts, hollow wall fasteners, or concrete block anchors. Sheetmetal screws shall be used on metal studs and wood screws used on wood construction. Attachment by wood plugs or wood blocking is not permitted.
11. Support vertical conduit runs at each floor slab with approved hangers.

3.2 CONDUIT INSTALLATION

A. General Requirements: All conduits shall be installed in accordance with the NECA Standard of Installation:

1. Cut conduit square using a saw or pipe cutter; de-burr cut ends.
2. Bring conduit to shoulder of fittings and couplings and fasten securely.
3. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp or wet locations.
4. Install no more than equivalent of four 90-degree bends between boxes for power circuits and two 90-degree bends for low voltage and communications circuits.
5. Avoid moisture traps where possible. Where unavoidable, provide junction box with drain fitting at conduit low point. Outdoor conduits shall be graded a minimum of six inches per one-hundred feet with no traps and shall be pitched to drain into manholes, pull boxes or suitable located drain tees.
6. Coordinate all conduits with other trades. Consult with Mechanical Contractor before installing conduits for electrical feeders so that conflicts between locations of conduit runs, piping, and ductwork will be adjusted prior to installation. In general, large pipe mains and air ducts shall be given priority in available space. Conduit runs shall be installed so as to maintain, wherever practical, a minimum separation of three inches from water and waste piping and six inches from steam piping.
7. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations.

B. Conduits in Soil or Slabs on Grade: Metallic conduit shall have a factory coating of 20 mil bonded PVC or shall be field coated on outside with asphaltum before installation. Couplings and damaged areas of coating shall be completely coated after installation. Conduits shall be at least eight inches below bottom of slabs on grade.

C. Conduits in Slabs Not On Grade: Conduits shall occupy the middle third when practical and have at least 1 1/4-inch concrete cover. Consult with the General Contractor to determine minimum allowable horizontal spacing between conduits to maintain structural integrity of floor slab. Conduits shall be tied to reinforcing rods to prevent movement or sagging during pour.

D. Conduits in Concrete Joists and Columns: No conduits shall be run in steel reinforced concrete joists, beams or columns without approval of Architect/Engineer; except for conduit runs to switches and receptacles specifically shown in columns.

E. Conduits in New Masonry Walls: Conduits shall be installed during wall construction or "fished in". No conduit shall be channeled in without special permission of Architect.

F. Horizontal Runs in Walls: No conduit shall run horizontally in concrete block or brick walls without approval of Architect/Engineer. Horizontal runs shall be made in floor or ceiling construction.

G. Conduits on Equipment: Conduits shall not be mounted on ductwork, boilers, ventilation units or other such mechanical equipment, except where necessary to make connections to electrical devices that are part of or mounted on such equipment. Where conduits must be run on equipment, care shall be taken not to cover access doors, controls, removable panels, etc., or otherwise hinder the normal maintenance and repair of the equipment.

H. Demising Walls: No conduit shall be installed within the air space between studs. Conduit shall be run on the stud side served.

I. Conduit Through Roofs: Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.

J. Expansion Fittings: Install expansion fittings where conduits in concrete slabs or in soil under slabs cross building expansion joints. Conduits installed in suspended ceiling spaces shall have offsets or bends adjacent to building expansion joints.

K. Conduits in Demountable Partitions: Conduit shall enter partitions from ceiling to facilitate future partition removal. No conduits shall enter from floors. A junction box shall be provided above ceiling at the point where conduit enters partition.

L. Conduits Through Exterior Walls: Where conduit systems pass through exterior walls or footings below grade, entrance shall be made watertight by providing pipe sleeves in wall with 1/2-inch minimum clearance around conduit and caulking with oakum or an approved non-hardening type caulking compound. Alternate acceptable method is by means of a conduit entrance seal, O.Z./Gedney Company, Type "FSK" or as approved by Engineer. Seal conduit stubs as described above. In addition, inside of conduit shall be sealed watertight with an approved non-hardening low to no VOC emitting type caulking compound packed around wires.

M. Conduits Above Furred or Suspended Ceilings: Branch circuit conduits and conduits feeding ceiling lighting shall not be supported by suspended ceiling lighting fixtures, mechanical piping or air conditioning ducts. Branch circuit conduits may be fastened to ceiling support members with fasteners designed for that purpose.

N. Conduit Sleeves: Same material as conduits required in the area. Both ends of sleeves shall have bushings.

3.3 GROUTING AND FIRE STOPS

A. General Requirements:

1. The contractor shall be responsible for grouting airtight any openings adjacent to conduits and other openings to seal against passage of air, smoke, or vapors. Openings around conduits through floors shall be sealed watertight.
2. The contractor shall seal around each conduit or conduit sleeve penetrating fire rated walls or partitions with sealant specified. Interior conduit sleeves in walls or partitions shall be sealed to provide a complete fire rated installation in accordance with sealant manufacturer's instructions.
3. All firestopping products shall be installed by experienced workers, familiar with the proper application and installation of appropriate UL fire stopping design rating systems. Contractor shall submit fire

stopping manufacturer's appropriate conduit and conduit sleeve penetration system design criteria and UL approved number for each type of UL fire stopping design rating system used on the project prior to installation.

3.4 CONDUIT STUB-UPS

A. Stubbed Up Through Floor Slabs: Where conduit is called to be stubbed up at an exposed location, a rigid conduit threaded coupling shall be installed flush with finish floor. Provide a recessed pipe plug, flush with floor, in each stub-up.

3.5 EMPTY CONDUITS

A. Identification: Empty conduits installed for future use shall have markers and identification at terminations. Empty boxes shall be marked with the system named in a visible place on the exposed cover plate.

END OF SECTION 26 05 33.10

SECTION 26 05 33.11
OUTLET BOXES

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide outlet boxes of heavy gauge galvanized steel, of knockout type, wherever required by the Drawings and Specifications.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Recognized Manufacturers of electric outlet boxes, manufactured in accordance with the latest edition of the National Electric Code (NEC) and industry standards.

2.2 MATERIALS

A. Ceiling Boxes: 4-inch octagonal ceiling boxes shall be used, except as otherwise specified. For additional wire space 4 11/16–inch square boxes may be used. Outlet boxes for fixtures shall be complete with fixture studs.

B. Wall Boxes: 4-inch square wall boxes shall be used with one or two device raised cover. Raised covers or tile rings shall be flush with finished walls.

1. Boxes in plastered walls shall be standard 4-inch square boxes with appropriate plaster rings.
2. Boxes in brick, exposed concrete block, glazed tile and wood paneled walls shall be 4-inch square having a raised cover with straight sides not less than 1-inch. 4 11/16- inch square box may be used for additional wire space. Where thickness of masonry or more than two gangs are required 3 ¾-inch high masonry boxes may be used.
3. Switch boxes in door frames shall be Raco No. 426 with Sierra narrow plates.
4. Boxes that are surface mounted shall be 4-inch square with pressed steel plates. Where mounted within six inches of a floor, box type shall be “FS” or “FD”.
5. Straight through and sectional switch boxes shall not be used.
6. Flanged airtight boxes shall be NuTek Airtight #FWSW series.

Part 3. - EXECUTION

3.1 INSTALLATION

A. General Requirements:

1. Boxes shall not be recessed back-to-back on opposite sides of wall, offset a minimum of six inches. Through wall boxes shall not be used.
2. Boxes shall be roughed-in to provide a neat appearance. Centerlines of boxes shall be aligned vertically and horizontally. Boxes shall be symmetrically located with the major architectural features when they occur between doors and windows and in wood panels.
3. Adjust horizontal position of boxes such that bottom of box is located on top of masonry coarse and vertical centerline is either on a masonry course or centered on a masonry unit. Contractors shall coordinate with other trades, so boxes are installed with no unsightly joints around them.
4. Boxes shall be installed such that the front of box is flush with finished wall, boxes more than ¼ inch back from finished wall shall not be acceptable.

5. Boxes used for narrow fluorescent fixtures shall have openings of such a size that they will be completely covered by fixtures.
6. Boxes in finished ceiling construction shall be supported by structural building members or when necessary to bar hangers or steel channels supported by either structural building members or ceiling framing channels. Exposed boxes shall be secured to the structure by toggle bolts, wood screws or lead anchors.
7. Provide acoustically rated, flanged, airtight boxes in all corridor walls, all top floor ceilings, unit corridor walls, unit party walls, unit exterior walls and unit floor/ceiling assemblies. Drop ceiling boxes to make proper air-tight seal with gypsum board ceiling.
8. Putty pads shall wrap boxes completely and shall extend to the back of structure or building material or shall encase box completely.
9. Within demising walls, offset boxes to comply with National, State and Local Codes.
10. Contractor shall coordinate height and location of boxes with Architectural elevations and other trades so as not to conflict with other work or equipment. Boxes shall not interfere with door trim. It shall be the Electrical Contractor's responsibility to move boxes that conflict with others at no additional cost to the Owner.

END OF SECTION 26 05 33.11

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide pull boxes to facilitate the pulling of wires or when more than four quarter bends occur in any conduit run. No attempt has been made to show all necessary boxes on Drawings.

Part2. - PRODUCTS

2.1 MATERIALS

A. Type:

1. Pull and junction boxes shall be sized and installed to meet the requirements of Article 314 of the latest edition of the National Electric Code (NEC).
2. Provide galvanized code-gauge sheet steel junction and pull boxes.

Part 3. - EXECUTION

3.1 INSTALLATION

A. General Requirements: Pull and junction boxes shall be located to be accessible after building is finished. Pull and junction boxes shall not be placed in any finished spaces without prior approval of Architect/Engineer. No boxes shall be installed above plaster ceilings without prior approval of Architect/Engineer.

1. Pull boxes installed above lay-in ceiling tiles shall be within twenty-four inches of ceiling for accessibility and shall not conflict with removal of ceiling tiles.
2. Pull boxes shall be within twenty-four inches, where installed above access panels.

3.2 CONDUCTORS IN PULL BOXES

A. General Requirements: Conductors shall be of sufficient length within pull boxes to neatly train conductors without excess.

3.3 IDENTIFICATION

A. Pull Boxes: Pull boxes shall be identified as to type of system in box as follows:

1. Stencil cover plate with 1/2-inch black letters in non-finished areas.
2. Identify with a tag inside of box in finished areas.
3. Paint boxes red and stencil "FIRE ALARM" for all boxes used for fire alarm and detection systems.
4. Provide colored conduit if installed in the existing facility, field verify.

B. Conductors: Identify in a permanent neat and legible manner all conductors or cables within box by means of tags, pressure sensitive tape or cable ties.

END OF SECTION 26 05 33.12

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide wireways wherever required by the Drawings and Specifications, or at Contractor's option. Provide wireways with all fittings, connectors, and accessories for a complete installation. The contractor shall provide wireways in equipment spaces where electrical equipment is grouped or larger panelboards requiring them.

Part 2. - PRODUCTS

2.1 MATERIALS

A. Type: Provide wireways manufactured for the electrical industry by recognized manufacturers, in accordance with the latest edition of the National Electrical Code (NEC), labeled by a nationally recognized testing laboratory.

1. Wireways shall be steel troughs without knockouts and with hinged cover.
2. Unless otherwise noted wireways shall be sized for the number of conductors to be installed in accordance with the latest edition of the NEC but shall not be less than sixteen square inch area.

B. Finish: Wireways shall be galvanized steel with gang-able hinge and joints secured with sheet metal screws. Provide 16-gauge sheet metal for 6-inch x 6-inch wireways and smaller. Provide 14-gauge sheet metal for larger wireways up to 12-inch x 12-inch. All wireways shall contain a rust inhibitor and shall be finished with baked enamel. Wireways installed outdoors or within other similar corrosive atmospheres shall be manufactured to suit respective uses.

Part 3. - EXECUTION

N/A

END OF SECTION 26 05 33.13

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Unless specifically noted or specified otherwise, install all electrical wiring in an enclosed raceway system. Raceway materials shall be as specified in Section 26 05 33.10.

1.2 DESIGN REQUIREMENTS

A. Raceway Size: Raceways should be sized to meet the minimum requirements of the latest edition of the National Electrical Code (NEC) and all state and local codes and ordinances. Where raceway sizes are indicated, provide raceways shown.

B. Conduit Fill: Conduit fill shall be based on THWN conductors, at 75° C, as listed in the latest edition of the NEC. Derating shall be considered when sizing conduits. Provide increased conduit size where required.

Part 2. - PRODUCTS

N/A

Part 3. - EXECUTION

3.1 INSTALLATION

A. Concealed: Raceways shall be installed concealed, unless specifically noted or otherwise specified. Generally, raceways shall be installed exposed only on walls and ceilings of unfinished rooms, equipment rooms or where indicated on Drawings.

B. Continuous System: Raceway systems shall be complete from outlet to outlet and from cabinets and junction boxes. Raceway systems shall enter and be secured to boxes and cabinets in such a manner that the system shall be electrically continuous from point of origin to outlets.

C. Mounting: Raceways shall not be mounted on boilers, ventilation units or other mechanical equipment, except where necessary to make connections to electrical devices that are part of or mounted on such equipment.

D. Interference: Coordinate with the Mechanical Contractor prior to installing conduit or pull boxes for electrical feeders to avoid conflicts with locations of raceway runs and mechanical equipment. Revisions to the raceway system made to avoid conflicts shall be at no additional cost to the Owner.

END OF SECTION 26 05 35

SECTION 26 09 13
CONTROL DEVICES

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide control devices wherever required by the Drawings and Specifications.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Control devices shall be as follows:

1. Lighting Contactors:
    a. Challenger
    b. Cutler-Hammer
    c. Square D
2. Time Clocks:
    a. Tork
    b. Intermatic
3. Occupancy Sensors:
    a. Leviton
    b. Sensor Switch
    c. Hubbell
    d. Wattstopper
4. Photo Control
    a. Tork
    b. Or approved equal
5. Thermostats
    a. Honeywell

2.2 PRODUCT

A. Lighting Contactors (Square D model numbers are provided for cross referencing):

1. LC-1: Multi-pole, 30 amp, 277 volt, mechanically held, 120 volt control coil. NEMA 1 enclosure. Square D#LXG0V02. Provide poles as required for interior or exterior lighting control.

B. Time Clocks (Tork model numbers are provided for cross referencing):

1. TC-1: 24-hour, 40-amp, 208/277 volt, DPST, skip-a-day, astro dial, 277-volt control coil, NEMA 1 enclosure. Mechanical: Tork #7202Z. Digital: Tork #EWZ103.
2. TC-2: 24-hour, 40-amp, 208/277 volt, DPST, skip-a-day, 277-volt control coil, NEMA 1 enclosure. Mechanical: Tork #7202. Digital: Tork #EW103B.
3. TC-3: 24-hour, 40-amp, 208/277 volt, DPST, skip-a-day, astro dial, photo control, 277-volt control coil, NEMA 1 enclosure. Mechanical: Tork #7202Z with #2000-2 or #EWZ103 WITH #200.
4. TC-4: 24-hour, 40-amp, 208/277 volt, 3PST, skip-a-day, astro dial, photo control, 120-volt control coil, NEMA 1 enclosure. Mechanical: Tork #7302Z with #2000-2. Digital: Tork #EWZ101 with #5401 contactor.
5. TC-5: 24-hour, 10-amp, 120-volt, SPDT, skip-a-day, 15-minute multiple interval timer, up to 48 on/off operations per day, 120-volt control coil, NEMA 1 enclosure. Mechanical: Tork #8007. Digital: Tork #DG180A.

C. Photo Control (Tork model numbers are provided for cross referencing):

1. PC: Exterior, 1100va, 120 volt, SPST, swivel tube. Tork #2000.
2. PC: Exterior, 1900va, 208-277 volt, SPST, slider adjustment. Tork #2000-2.
3. PC: Interior, 1100va, 120 volts, SPST. Tork #3000.
4. PC: Interior, 1100va, 208-277 volt, SPST. Tork #3002.

D. Occupancy/Vacancy/Daylight Sensors (Sensor switch model numbers provided for cross referencing):
1. L-W1 (Wall): Passive dual technology sensing (infrared/microphonic), 180° coverage, 20-foot detection, 30 second to 30 minutes off timer adjustment, one manual on switch, raise/lower control, green LED status indicator, low voltage. Sensor Switch #nWSX PDT LV-DX-XX (color selected by Architect).
2. L-W2 (Wall): Wall station, raise/lower control, manual on switches, green LED status indicator, low voltage. Sensor Switch #nPODM-XX-DX Series (color selected by Architect).
3. L-W3 (Wall): Wall station, manual on switches, green LED status indicator, low voltage. Sensor switch #nPODM (color selected by Architect).
4. L-W4 (Wall): Wall station, raise/lower control, low voltage with dual technology. Sensor Switch #WSX PDT-D-SA Series.
5. L-C1 (ceiling, small area, photocell with dimming): Passive dual technology sensing (infrared/microphonic), 360° coverage, 12-foot detection at 9 feet AFF, 30 second to 20 minutes off timer adjustment, green LED status indicator, low voltage. Sensor Switch #nCM PDT 9 ADCX.
6. L-C2 (ceiling, small area): Passive dual technology sensing (infrared/microphonic), 360° coverage, 12-foot detection at 9 feet AFF, 30 second to 2 minute off timer adjustment, green LED status indicator, low voltage. Sensor switch #nCMPDT9.
7. L-C3 (ceiling, large area, photocell with dimming): Passive dual technology sensing (infrared/microphonic), 360° coverage, 28-foot detection at 9 feet AFF, 30 second to 20 minute off timer adjustment, green LED status indicator, low voltage. Sensor Switch #nCM PDT 10 ADCX.
8. L-C4 (ceiling, large area, corridor): Passive dual technology sensing (infrared/microphonic), 360° coverage, 28 foot detection at 9 feet AFF, 30 second to 20 minute off timer adjustment, green LED status indicator, low voltage. Sensor Switch #nCM PDT 10.
9. Power Pack: Low voltage dimming control, 120/277 volts, 20 amp rated load, 0–10-volt dc output, plenum rated. Sensor Switch #nPP16 series.

E. Thermostats (Honeywell model numbers are provided for cross referencing).

1. Heating/cooling, 120-volt, medium duty, 44° F to 86° F range (minimum), gold face-plate with beige cover, breaks heating and makes cooling on temperature rise, heat/cool selector switch. Honeywell #T651A 3018.

Part 3. – EXECUTION

3.1 INSTALLATION

A. Photo control shall be wall mounted on a stainless-steel plate supported by a recessed electrical box.

B. Contractor shall make all required connections to control devices.

C. Occupancy/Daylight Sensors:

1. Provide dedicated backbox for wall mounted occupancy sensors.
2. The contractor shall review lighting control plans prior to bid. Provide additional sensors required for a complete and fully functional system.
3. Provide power packs per manufacturer's requirements to properly control fixtures and receptacles within rooms.
4. Provide low voltage and line voltage connections between power packs, sensors, switches and controlled equipment per manufacturer's requirements for a complete and fully functional system within each room or area.
5. Mount power packs within j-boxes located above accessible ceiling, either within room or adjacent corridor. If accessible ceilings are not available, provide flush j-box behind room entry door, mounted low, with screw cover. The cover shall be painted to match the wall finish.
6. Wall mounted occupancy sensors shall be set to manual on/auto off.
7. Provide control of code required office receptacles, see floor plans.

D. Sensor placement shown on plans is diagrammatic only and actual sensor placement and final quantity shall be as determined by the sensor manufacturer. Material and labor costs associated with the final quantities of components required shall be the responsibility of the Contractor.

E. Provide locking plastic cover for thermostats located in public areas.

F. Normal and Unfinished Areas: Wall mounted occupancy sensors and thermostats shall be mounted at the following heights, measured from top of device to floor, unless noted otherwise.

1. Occupancy sensor 48"
2. Thermostat 60"

G. Handicapped Areas, Living Units: Wall mounted occupancy sensors and thermostats shall be mounted at the following heights, measured from top of device to floor, unless noted otherwise.

1. Occupancy sensor 44"
2. Thermostat 44"

H. LED fixtures within corridors shall be dimmed at or near the nurses station.

I. The Contractor shall confirm the number of buttons provided for wall switches is adequate for the design requirements.

END OF SECTION 26 09 13

SECTION 26 24 16.10
PANELBOARDS

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide panelboards wherever required by the Drawings and Specifications.

1.2 SYSTEM DESCRIPTION

A. Circuit Numbers: Circuit numbers shown on Drawings shall be used for reference only. Actual connections shall be in accordance with phasing of cabinet, load balance and common neutral requirements.

1.3 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Construct panelboards to NEMA.

B. Underwriters' Laboratories (UL): Equipment shall be in accordance with Section 26 00 10.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All panelboards shall be as follows:

1. AMP (Cutler-Hammer Components)
2. Cutler-Hammer
3. EMI (Cutler-Hammer Components)
4. General Electric
5. Siemens-ITE
6. Square D
7. States Electric

2.2 COMPONENTS

A. General Requirements: Panelboards shall be dead front safety type and shall be UL listed.

B. Enclosures: Enclosures shall be constructed of code grade steel with concealed trim clamps and hinges. Panel front shall be lockable with all panels throughout the Project keyed alike. Provide two keys for each panel.

C. Lugs: Solderless lugs only shall be provided in mains, unless otherwise noted on the Drawings and/or the Panelboard Schedule. Main lugs shall be suitable for both 60° C and 75° conductors. Main and neutral lugs shall be compression type. Provide sufficient number of lugs to individually terminate each conductor.

D. Buses: Provide buses made from 98% electrolytic copper or 55% conductivity aluminum and independently supported without dependence upon circuit breakers.

E. Gutters: Provide oversized gutters for feed through, where indicated or required. Where double lugs are not

permitted by local code authorities, provide suitable pull box or gutter adjacent to panels for connections. Feeder wiring shall be capable of accepting a clamp-on ammeter.

F. Molded Case Circuit Breakers: Provide circuit breakers as follows:

1. Bolt-in type.
2. Multi-pole breakers shall be common trip and reset, with one handle.
3. Rated for 10,000 amperes for 120/208-volt systems, minimum, in lighting and appliance panelboards. Rated for 35,000 amperes, minimum, for all distribution panelboards.
4. Contain HACR label when feeding heating, air conditioning or refrigeration loads.

G. Fusible Switches: Provide quick-made, quick break fusible switches.

H. Special Panelboard Requirements:

1. The following shall be provided as specified:

a. Panelboards with wireways above or below the panelboard shall have conduit enclosures of the same size and finish as the panelboards with removable, screw attached, front covers.
b. Panelboards with double tubs shall have separate individualized fronts for each tub.
c. Provide lock-offs over required breaker handles as noted or as required, per NEC Code.
d. Provide GFI and AFI breakers as noted or required per NEC Code.

2.3 ADDITIONS TO EXISTING PANELBOARDS

A. General Requirements: Provide circuit breakers or fused switches where new circuits are to be added to existing panelboards. Circuit breakers and switches shall be the same manufacturer and same type as existing.

2.4 ARC FLASH WARNING LABEL

A. Provide arc flash warning label per Code.

B. Label shall include calculated arc fault current.

C. Labeling and calculated values shall be included with shop drawing submittals.

2.5 SPARES/SPACES

A. At project turnover, panelboards shall contain, at a minimum, spaces for 20% additional single pole breaker.

Part 3. - EXECUTION

3.1 INSTALLATION

A. General Requirements:

1. Feeder and branch circuit conduits shall meet the cabinet squarely and shall be arranged to facilitate training of conductors to their respective terminals.
2. The top of panelboard tubs shall be mounted no more than 6 feet above finished floor.

3.2 SPARE CONDUITS

A. General Requirements: Provide three 3/4-inch empty conduits from each flush mounted panelboard to accessible

ceiling space or area above panelboard for future panel connections. Empty conduits shall be capped.

3.3 IDENTIFICATION

A. Panel Identification: Equipment shall be labeled per Section 26 00 50. Where equipment is located are in mechanical spaces or in storage rooms, provide identification plates on the front exterior. Match existing facility, Kroy labeling not acceptable.

B. Circuit Identification:

1. Circuit Breaker Panelboards: Provide typed directories identifying all circuits with clear plastic cover mounted in a card holder. Room numbers or names used for circuit identification shall correspond to nameplates installed on room doors by General Contractor or as selected by Owner and shall be verified as these may not be the same as room titles on Drawings.
2. Fused Panelboards with Doors: Provide typed directories identifying all circuits with clear plastic cover mounted in a card holder.
3. Switchboards and Fused Panelboards Without Doors: Panelboards shall have micarta plates with 3/8-inch-high white cut letters identifying each circuit or component.

3.4 ADDITIONS TO EXISTING PANELBOARDS

A. General Requirements: Provide the proper circuit breaker or fused switch with overcurrent protection for each circuit where new circuits are indicated to be connected to an existing panelboard. Where a panelboard does not have space to accommodate additional overcurrent protection devices, provide a fused switch near the panel and tap the circuit into the panelboard bussing. The contractor shall field verify the conditions of existing panelboards prior to bidding.

B. If panel label does not exist, label panel in same manner as new panels.

C. Provide updated directories similar to new panels.

END OF SECTION 26 24 16.10

SECTION 26 24 19
MOTOR CONTROLS

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In general, all motors indicated in the Mechanical and Electrical Equipment Schedule or as shown on the Drawings are furnished, set in place, and mounted by others. Motor locations and mounting heights are approximate and shall be verified with the motor installer.
2. Provide a feeder from a panelboard through a disconnecting switch and starter to each motor. Provide final connections to each motor and check each motor for proper rotation.
3. Provide all disconnects and starters, unless specifically noted as "Furnished By Others", in which case install disconnects and starters for a complete system.
4. Refer to the Electrical Equipment Schedule Notes for additional control requirements.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All motor control devices shall be of the same manufacturer as follows (Square D catalog numbers are used to specify required type):

1. Allen-Bradley
2. Cutler-Hammer/Eaton
3. Furnas
4. General Electric
5. Siemens
6. Square D

2.2 COMBINATION UNITS

A. General Requirements: Provide combination devices where a disconnect switch is indicated at the same location as a magnetic starter.

2.3 DISCONNECTING MEANS

A. General Requirements: Provide all disconnect switches, except where specifically noted as "Furnished By Others", in which case install switches for a complete system.

B. Type: Disconnect switches shall be as follows:

1. Heavy duty type, fusible, unless noted.
2. NEMA 1 enclosure, except NEMA 3R where installed outside or on roof.
3. Motor rated for proper horsepower.
4. Proper voltage rating.
5. Fuses shall be sized as specified in Section 26 28 13.
6. Electrical interlock to disconnect all separately derived control circuits or interlock wiring.
7. Terminals suitable for both 60°C and 75°C conductors.

2.4 MAGNETIC STARTERS

A. General Requirements: Provide all magnetic starters, except where specifically noted as "Furnished By Others", in which case install magnetic starters for a complete system.

B. Type: Magnetic starters shall be non-reversing type (Square D, Clas 8536). Each starter shall be complete with all of the following features:

1. Full voltage, across-the-line, horsepower rated. Terminals suitable for both 60°C and 75°C conductors.
2. Surface mounted NEMA 1 enclosure, except NEMA 3R, where installed outside or on roof.
3. Motor running over-current protection in each ungrounded conductor. Electrical Contractor shall verify actual name plate current ratings of each motor prior to installation over-current protection.
4. Low voltage release.
5. Holding coil of proper voltage.
6. Control Transformer: Provide a transformer of the same voltage as the holding coil, within each magnetic starter. Transformers shall be complete with both primary and secondary fusing.
7. Hand-Off-Auto Selector Switch: Switch shall be mounted on starter cover and connected in circuit such that protective devices remain in circuit in both auto and hand positions (Square D, Class 9999).
8. Pilot Light: Pilot light shall be mounted on starter cover and shall be complete with red lens and lamp (Square D, Class 9999).
9. Auxiliary Contacts: Provide a minimum of four auxiliary contacts per starter.

2.5 MANUAL STARTERS

A. General Requirements: Provide all manual starters indicated, except where specifically noted as "Furnished By Others", in which case install manual starters for a complete system.

B. Type: Manual starters shall be as follows:

1. Full voltage, across-the-line, horsepower rated.
2. One motor running over-current protector in each ungrounded conductor.
3. In finished areas, all manual starters shall be flush mounted in plates to match device plates sized to fit standard outlet boxes (Square D, Class 2510). Manufacturer’s direction plate for resetting overloads shall be installed on flush plates. Plates shall be engraved as noted in the Mechanical and Electrical Equipment Schedule.
4. Where exposed conduit is permitted, manual starters (Square D, Class 2510) shall be in surface boxes.
5. Pilot lights with manual starters shall be red neon jewel type. Pilot lights shall be connected to conductors at the actual motor location in order to indicate that the motor is running.

2.6 CONTROL STATIONS

A. General Requirements: Provide all control devices. In finished areas, all control stations shall be flush mounted in plates to match device plates and of a size to fit standard outlet boxes.

B. Type: Control stations shall be as follows:

1. Start-Stop Maintained Stations: Maintained contact type for 2-wire control of magnetic starters. Actuator buttons shall be engraved start-stop (Square D, Class 9001).
2. Start-Stop Momentary Stations: For 3-wire control of magnetic starters or relays. Engrave actuator buttons “start-stop” (Square D, Class 9001).
3. Toggle Switch Stations: Provide standard toggle switches as specified under Section 26 27 23.
4. Pilot Lights: Pilot lights at start-stop stations shall be LED type with red lens. Pilot lights at the toggle switches shall be neon type mounted in separate gangs of device plates. Pilot lights shall be connected to

conductors on load side of disconnect at motor in order to indicate that motor is running.

5. Float Switches, Pressure Switches, P.E. Switches, and E.P. Switches: The Device shall be furnished and installed by others but connected by Electrical Contractor. Verify location of such equipment with the installer.
6. Special Key Switches: Each key switch, including special wall outlet boxes and engraved plates shall be furnished by others but installed by an Electrical Contractor.
7. Limit Switches: Switches shall be furnished and set in place by others but installed by Electrical Contractor. The number of limit switches and function shall be coordinated with equipment suppliers' Shop Drawings.
8. Snap Switch: Control motor with switch on the Drawings.
9. Duct Heat or Smoke Fire Detectors: Refer to Fire Alarm and Detection Specifications.
10. Engraving: Provide engraving of remote motor control stations to properly identify station.

Part 3. - EXECUTION

3.1 INSTALLATION OF DISCONNECTS AND STARTERS

A. General Requirements: Provide disconnecting switches and starters. If not specifically noted otherwise, provide all disconnect switches and starters for a complete system.

B. Starters and Disconnect Locations: Locations shall be coordinated on site to clear other equipment, provide proper accessibility, and provide ease of maintenance. Starters and disconnects shall be installed with clearances by the NEC. Starters and disconnects shall be installed in locations that do not provide required clearances only with the prior approval of both the Electrical Inspector and Architect/Engineer. In general, starters and disconnects shall be located near the motors, wall mounted not more than 6 feet above the floor or mounted on equipment where readily accessible from the floors and shall not be mounted over live or moving parts. When indicated to be installed above finished ceilings, starters and disconnects shall be located within 24 inches of ceiling for ease of maintenance and accessibility.

C. Elevator: Shunt-trip circuit breaker(s) (STB) shall be located in the elevator equipment room immediately next to knob side of equipment room entrance door. Coordinate exact location with elevator inspector.

D. Starter Overloads: Provide running current protection in each starter based on actual motor nameplate readings and overload manufacturer's selection tables.

3.2 INSTALLATION OF CONTROLS

A. General Requirements: Provide all control wiring. Provide adequate auxiliary contacts and relays to accomplish interlocks and subsidiary control connections. Coordinate all work with Mechanical and Temperature Control Contractors, such that operation of mechanical equipment will be as described in Mechanical Specifications.

B. Hand-Off-Auto Operation: Where equipment does not have automatic control, connect the hand-off-auto selector switch for manual operation with automatic position available for future use. Connections to selector switch shall be such that only normal automatic regulatory control devices will be bypassed when switch is in manual position; safety control devices, such as low- or high-pressure cutouts, high temperature cutouts and motor overload protective devices, shall be connected in motor-control circuit in both manual and automatic positions of the selector switch.

3.3 MOTOR CONNECTIONS

A. General Requirements: Provide feeders from panelboards, through disconnecting switches and starters, to all motors. Flexible metal conduit shall be used for final connections to motors and shall not be less than 12 inches nor more than 24 inches in length. Flexible metal conduit in boiler rooms, kitchens and mechanical rooms shall be liquid tight type. Provide a separate grounding conductor within flexible conduit, bonded to conduit system, for motors.

B. Connections to Roof Mounted Motors: Provide weatherproof connections to all roof mounted motors.

C. Connections to Wall Hung Water Coolers: Install in accordance with cooler manufacturer's requirements. Conceal receptacle behind cooler enclosure at all devices where possible.

D. The Electrical Contractor shall thoroughly review installation manuals for each piece of equipment requiring power and control connections. Obtain instruction manuals from the Mechanical Contractor, Plumbing Contractor, or Owner prior to roughing in any feeders or control wiring. Notify the Engineer of any discrepancies between the electrical plans and specifications and the equipment installation manuals prior to any installation. If for any reason this Contractor fails to do so, all costs necessary to correct discrepancies shall be borne by the Electrical Contractor.

3.4 LABELING AND ENGRAVING

A. Labeling: Provide labels inscribed with both the motor name and number attached to each motor disconnect and to each motor starter or combination switch-starter. Each motor’s name shall be indicated in the Mechanical and Electrical Equipment Schedule. On projects where no Equipment Schedule is provided, motor names shall be as directed by Engineer. Labels shall be black micarta plastic laminate plates with 1/4-inch-high white cut letters.

B. Engraving: Provide identification on remote motor control pushbutton stations, momentary contact stations and hand-off-auto stations. Flush plates shall be engraved with Sierra permanent type filled letters. Surface mounted control stations shall have 1/4-inch-high white cut letters on black micarta plates.

END OF SECTION 26 24 19

SECTION 26 27 23
WIRING DEVICES

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide all labor, materials and accessories to install and connect wiring devices wherever required by Drawings and Specifications.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All wiring devices shall be of the same manufacturer as follows (Leviton and Hubbell catalog numbers are used to specify required type and quality):

1. Cooper
2. General Electric
3. Hubbell
4. Leviton
5. Pass & Seymour
6. Slater
7. Sierra

B. Acceptable Manufacturers: All wiring devices shall be of the same manufacturer as follows:

1. Cooper
2. Leviton
3. Sierra
4. Slater

2.2 DEVICE COLOR

A. General Requirements: Unless noted otherwise, all wiring devices and wall plates shall be coordinated with the Architect. Submit samples to Architect for review and approval.

B. Emergency Power: Receptacles connected to emergency power shall be red.

2.3 SWITCHES

A. General Requirements: Switches for lighting loads shall be 15 amp or 20 amp, 120 volt, quiet toggle type and side wired.

B. Switches shall be the following:

1.	15 amp, 120/277 volt, single pole	Leviton #1201-2X
2.	20 amp, 120/277 volt, single pole	Leviton #1221-2X
3.	15 amp, 120/277 volt, 3-way	Leviton #1203-2X

4.	20 amp, 120/277 volt, 3-way	Leviton #1223-2X
5.	15 amp, 120/277 volt, 4-way	Leviton #1204-2X
6.	20 amp, 120/277 volt, 4-way	Leviton #1224-2X
7.	20 amp, 120/277 volt, 2-pole	Leviton #1222-2X
8.	24 volt, momentary contact, SPDT center off	Leviton #1081

C. Switches shall be the following:

1.	15 amp, 120 volt single pole	Leviton #1201-2X
2.	20 amp, 120 volt, single pole	Leviton #1221-2X
3.	15 amp, 120 volt, 3-way	Leviton #1203-2X
4.	20 amp, 120 volt, 3-way	Leviton #1223-2X
5.	15 amp, 120 volt, 4-way	Leviton #1204-2X
6.	20 amp, 120 volt, 4-way	Leviton #1224-2X
7.	20 amp, 120 volt, 2-pole	Leviton #1222-2X
8.	24 volt, momentary contact, SPDT center off	Leviton #1081

D. Door frame switches shall be Pass & Seymour No. ACD-201 or ACD-203, complete with mounting straps and stainless steel plates.

E. Timer switches shall be Leviton LTB30-1L, electronic with four presets, up to 30 minutes, rated for 1000 watts/1hp motor.

2.4 CONVENIENCE OUTLETS

A. General Requirements: Duplex receptacles shall be 15 amp or 20 amp, 125 volt, 3-wire, grounding type, quickwire push-in and side or back and side wired. Install 20 amp rated duplex receptacles in all common areas. All receptacles shall be installed with the ground slot down. Provide GFI receptacles where shown or required by the National Electrical Code (NEC) and install with ground slot down.

B. Receptacles shall be the following:

1.	15 amp, 125 volt	Leviton #BR15-X
2.	15 amp, 125 volt, GFI	Leviton #7599-X
3.	15 amp, 125 volt, controlled	Leviton #16252-1PX
4.	20 amp, 125 volt	Leviton #BR20-X
5.	20 amp, 125 volt, GFI	Leviton #7899-X
6.	20 amp, 125 volt, controlled	Leviton #16352-1PX

C. Special receptacles shall be the following:

1.	20 amp, 250 volt	Leviton #5821-X
2.	30 amp, 125/250 volt, 3-pole, 4-wire, grounding	Leviton #278
3.	50 amp, 125/250 volt, 3-pole, 4-wire, grounding	Leviton #279

D. Receptacles shall be the following:

1.	15 amp, 125 volt	Leviton #8200-X
2.	15 amp, 125 volt, GFI	Leviton #6598-HGX
3.	15 amp, 125 volt, controlled	Leviton #16252-1PX
4.	20 amp, 125 volt	Leviton #8300-X
5.	20 amp, 125 volt, GFI	Leviton #6898-HGX
6.	20 amp, 125 volt, controlled	Leviton #16352-1PX

E. Receptacles with USB ports shall be 20 amp, 125 volt, Leviton #T5632-W. Outlets are identified on plan with "USB".

F. Exterior receptacles shall be low profile, recessed, weatherproof (WP) with cord openings and expandable cover. Hubbell Taymac #ML450 (G, W, or Z) grey, white or bronze.

G. Exterior in-ground Receptacle shall be garden post with integrated cover for GFCI power. Coordinate color with Architect, black, brown green or white. Arlington #GPD19B.

2.5 DIMMERS

A. General Requirements: Provide all dimmers as shown on the Drawings.

B. Provide dimmer rated 0-10volt with on/off function for all LED dimmed lighting. Match existing facility manufacturer and standard.

2.6 DEVICE PLATES

A. General Requirements: Device plates shall be provided for all devices shown on the Drawings or called for in the specifications. Device plates in finished and unfinished areas shall be plastic, unless noted otherwise. Multiple device plates shall be constructed of a single plate. No sectional plates will be accepted.

B. Special Screws: Where so indicated, device plates shall be complete with special tamperproof spanner oval head screw. Furnish Owner with three special screw drivers for the spanner head screws.

C. Engraved Plates: Engraved plates shall have letters sized at 1/8-inch minimum letter height and black filling. Printed tape or glued on plates are NOT acceptable. The following plates shall be engraved:

1. Wall plates so indicated on Drawings.
2. Switch wall plates controlling any lights which are out of sight of switches.
3. Switch wall plates controlling motors.

D. Commercial Kitchen Device Coverplates: Provide 302 stainless steel plates for all devices indicated.

Part 3. – EXECUTION

3.1 INSTALLATION OF DEVICES

A. General Requirements: Device height shall be as follows, except where noted otherwise on the Drawings:

1. Normal Areas and Rooms, Unfinished Areas: Switches, receptacles and outlets shall be mounted at the following heights, measured from device center to floor, unless noted otherwise. Match existing facility device heights.

a.	Receptacle	Match
b.	Telephone outlet	Match
c.	Telephone outlet, wall	Match
d.	TV outlet	Match
e.	Switch	Match
f.	Devices above counter without backsplash	8" above counter
g.	Devices above counter with backsplash	4" above backsplash

B. The Contractor shall coordinate the mounting height of all special receptacles with the Architect, Owner, Mechanical Contractor and equipment suppliers.

C. Where locations shown or mounting heights specified for devices conflict with other trades or building finishers, the Contractor shall coordinate exact requirements prior to installation and install only after the approval of all involved.

D. Provide spacers between outlet boxes and devices so that each device is flush with the finished wall. Plate screws shall not be used to stabilize device.

E. Location:

1. Receptacles along side of switches in janitor closets, storage rooms and mechanical spaces shall be in 2-gang boxes, with switch in first gang and receptacle in second gang.
2. Switches near doors shall be located on side opposite the hinges (verify door swings with Architectural Drawings before installation) and close to door trim. Edge of switch plate shall be within four inches of door frame.
3. Devices located at counters shall be mounted eight inches from device center to top of counter, unless noted otherwise.
4. Switches controlling range hood fan and lights, garbage disposals, undercabinet lighting, etc., in handicapped units shall be installed in the cabinet front. Coordinate the exact available location with the Architect.

F. Provide dedicated neutral and ground wire to each dimmer or timer switch if required.

G. Controlled Receptacles:

1. Split wired receptacles shall be half-controlled on bottom half of receptacle. Coordinate exact requirement with their energy code.
2. Controlled portion shall be labeled with NEMA approved marking on receptacle face.
3. Connect switched portion to room lighting control system.

3.2 MOVING DEVICES

A. The Owner, through the Architect/Engineer, reserves the right to move any device a distance of ten feet in any direction from the location shown on the Drawings without an increase in Contract amount. This requirement shall only apply to devices before installation.

B. In the event that an outlet shown on the Drawings will not be able to serve the specified piece of equipment, the outlet shall be relocated, with no increase in contract amount.

END OF SECTION 26 27 23

SECTION 26 28 13
FUSES

Part 1. - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, and accessories to protect feeders and branch circuits for panels, motors, and electrical appliances wherever required by the Drawings and Specifications or by applicable provisions of the National Electric Code (NEC).

Part 2. – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All fuses shall be of one manufacturer as follows:

1. Bussman
2. Littelfuse
3. Mersen

2.2 FUSE TYPES

A. 600 Ampere and Below (Bussman model numbers used to set the minimum standard for material and equipment):

1. All fuses shall have 200,000 amperes RMS interrupting rating.
2. Fuses shall be Underwriters' Laboratories Class J current limiting, dual element time delay, rejection type.
3. Fuses shall be Bussmann LPJ_SP.

B. 601 Ampere and Above (Bussman model numbers used to set the minimum standard for material and equipment):

1. All fuses shall have 200,000 amperes RMS interrupting rating.
2. Fuses shall be Underwriter' Laboratories Class L current limiting, time delay, pure silver link type.
3. Fuses shall be Bussmann KRP-C_SP.

C. Individual Motor Circuits (Bussman model numbers used to set the minimum standard for material and equipment):

1. Fuses shall be Underwriter' Laboratories Class R, current limiting, dual element time delay.
2. For fuses rated at 250 volt, provide Bussman LPN-RK_SP.
3. For fuses rated at 600 volt, provide Bussman LPS-RK_SP.

Part 3. – EXECUTION

3.1 FUSE INSTALLATION

A. General Requirements:

1. Provide fuses in all fusible switches, except switches identified as "spare or future".
2. Provide all fuses of ampere ratings required by the NEC to protect feeders and equipment.

3.2 SPARE FUSES

A. General Requirements:

1. Fuses 100 amps and smaller: Provide one standard size package of each size, type and amperage installed.
2. Fuses over 100 amps: Provide three spare fuses of each size, type and amperage installed.

B. Turn over spare fuses to the Owner prior to final closeout of the Project.

END OF SECTION 26 28 13

SECTION 26 28 16

SAFETY SWITCHES

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide safety switches wherever required by the Drawings and Specifications.

1. Every effort has been expended to provide an accurate list of equipment however, the Contractor shall verify motor nameplate on site before installing switches or selecting fuses.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: All safety switches shall be of one manufacturer as follows.

1. Cutler-Hammer
2. General Electric
3. I.T.E. (Siemens)
4. Square D

2.2 MATERIALS

A. Type:

1. Safety switches shall be fused. Non-fusible switches may be used in lieu of fusible where allowed by the National Electrical Code (NEC).
2. Safety switches shall be NEMA HD (heavy duty) type, horsepower rated, and of ampere sizes shown on Drawings or to comply with NEC. Safety switches shall have NEMA 1 enclosures, except in wet locations or where indicated as weatherproof, in which case a NEMA 3R enclosure shall be used. Locations on roof or outside shall be considered wet locations.
3. Fusible safety switches shall contain Class R fuse provisions to reject fuses, except Class R type.
4. Safety switches shall contain padlocking provisions and defeater screw mechanisms. Provide interlock contacts where so specified.
5. Safety switches shall be rated 240 volts, used on 120/208 volt or 120/240-volt ystems.
6. Switches rated 30 amperes through 100 amperes shall have lugs listed for 60° C or 75° C conductors. Switches rated over 100 amperes shall have lugs listed for 75° C.

B. Special Requirements for Elevator Installations:

1. Safety switches installed in elevator machine rooms for elevator power shall be shunt trip breakers, refer to Drawings.
2. Safety switches used for elevator power shall be provided with auxiliary contacts (one N.O. and one N.C.) controlled by the switch. The Contractor shall provide required conductors through the auxiliary contacts to the elevator controller.

2.3 ARC FLASH WARNING LABEL

A. Provide arc flash warning label per Code.

B. Label shall include calculated arc fault current.

C. Labeling and calculated values shall be included with shop drawing submittals.

Part 3. - EXECUTION

3.1 SUMMARY

A. This contractor shall review all Mechanical Equipment Schedule and plans and provide disconnects and fuses to comply with Code.

END OF SECTION 26 28 16

SECTION 26 43 13
SURGE PROTECTIVE EQUIPMENT

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide a Surge Protective Device (SPD) in new main switchboard or adjacent to existing main switchboard to protect building electrical system.

1. Provide a listed SPD in all emergency system panelboards.

1.2 QUALITY ASSURANCE

A. ANSI/IEEE:

1. C62.41, Categories A, B, and C
2. C62.45

B. Underwriters' Laboratories (UL): Devices shall be in accordance with Section 26 00 10.

1.3 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10. Shop Drawings shall include the following information:

1. Dimensional drawing of suppressor type, indicating mounting arrangements.
2. Category C3 (20KV, 10KA, 8/20 usec. waveform) clamp voltage test results.
3. UL 1449 clamp voltage documentation.
4. Graphical data demonstrating continuous attenuation capability between 100 Khz and 100 Mhz.
5. Provide arc flash warning labels and calculated values.

1.4 WARRANTY

A. Description: Manufacturer shall provide a product warranty for a period of not less than five years from the date of installation. The warranty shall cover unlimited replacement of system protection modules during warranty period.

Part 2. - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: As follows, no substitutions:

1. Current Technology, Inc.
2. LEA International, Inc.
3. United Power Corporation
4. Advanced Protection Technologies, Inc.

2.2 SURGE SUPPRESSORS

A. General Requirements:

1. Rated for distribution equipment 208-volt, 60 Hertz, 3 phase, 4 wire. Refer to equipment schedule.
2. Surge suppressors shall be in accordance with the following requirements:

    a. Device shall be parallel in design and connect in parallel to main switchboard, thereby not being limited in KVA capability.
    b. Device shall provide power conditioning and transient suppression capability bi-directionally, controlling both positive and negative impulses.
    c. Device shall provide line-to-line (L-L), line-to-neutral (L-N), line-to-ground (L-G), and neutral-to-ground (N-G) protection.
    d. Device shall provide maximum repetitive surge capacity, based on ANSI/IEEE C62.41, standard 8 by 20 microsecond current waveform of 150,000 amperes L-L, 150,000 amperes L-N, 75,000 amperes L-G, and 75,000 amperes N-G.
    e. Device shall provide maximum UL 1449 voltage clamping rating for each of the specified protection modes as follows:

        1) 400 Volts For 120, 120/208 Volt Systems

    f. Device shall include noise filtering capability to provide 50db minimum as measured by 50 ohm insertion loss test, between 100 Khz and 100 Mhz.
    g. Device shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status of each phase of the unit.
    h. Device shall incorporate diagnostic testing which verifies the operational integrity of the unit's suppression/filter system.
    i. System shall be provided with an internal safety interlocked disconnect system providing no interruption to the protected load for testing and maintenance. System shall not require removal and replacement for warranty or other repairs. All internal component replacements shall be capable of being completed by a licensed electrician.

2.3 ARC FLASH WARNING LABEL

A. Provide arc flash warning label per Code.

B. Label shall include calculated arc fault current.

C. Labeling and calculated values shall be included with shop drawing submittals.

Part 3. - EXECUTION

3.1 INSTALLATION

A. General Requirements: Devices shall be mounted to distribution boards and panelboards:

B. Grounding: Suppressors ground shall be bonded to service entrance ground.

3.2 TESTING

A. General Requirements:

1. Devices shall be inspected and tested at the factory, before delivery, to meet the required specifications. Test reports shall be provided.
2. Devices shall be inspected and tested in the field with a Diagnostic Test, set by a factory representative after installation, to meet the required specifications.

END OF SECTION 26 43 13

SECTION 26 51 00
LIGHTING

Part 1. - GENERAL

1.1 SUMMARY

A. Section Includes: Provide fixtures shown on Drawings complete with lamps as indicated in Light Fixture Schedule.

1.2 SUBMITTALS

A. Shop Drawings: Provide Shop Drawings in accordance with Section 26 00 10. Shop Drawings submitted for approval shall contain the following minimum information:

1. Manufacturer and type of driver for LED fixtures.

1. 3 QUALITY ASSURANCE

A. Underwriters' Laboratories (UL): Assemblies shall be in accordance with Section 26 00 10.

1. Lighting fixtures shall bear the UL label for wet or damp locations for the use intended.

Part 2. - PRODUCTS

2.1 LED'S AND DRIVERS, GENERAL REQUIREMENTS

A. General

1. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
2. Drivers shall be compatible with the lighting control system.
3. LED shall have a lumens/watt efficacy value which will meet the current State Energy Codes.
4. Provide 0-10 volt rated dimmer with on/off function for LED dimming control.
5. Drivers shall comply with FCC regulations for residential applications.

B. Approved Driver Manufactures:

1. Albeo
2. CREE
3. GE
4. Hubbel
5. Lithonia
6. Phillips

C. Interior Lighting

1. All LEDs shall have a color temperature as scheduled, minimum 85 CRI and a minimum life expectancy of 50,000 hours.
2. Exit lights shall be connected to the nearest emergency Life Safety un switched lighting circuit.

D. Exterior Lighting

1. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an

NRTL acceptable to authorities having jurisdiction. Luminaires shall be RoHS (restriction of Hazardous Substances) compliant.

2. Must be rigid structure with weather resistant and watertight enclosures.

2.2 EMERGENCY BATTERY UNIT

A. General Requirements: Wherever noted in the Light Fixture Schedule or Drawings emergency lighting units shall be as follows:

1. A self-contained storage battery is used as a second source of power.
2. Shall supply and maintain the total output for a period of 1½ hours minimum, without the voltage applied to the load failing below 87½% of normal light output.

2.3 LENSES

A. General Requirements: Provide lenses as noted in Luminaire Fixture Schedule.

2.4 RECESSED FIXTURES

A. General Requirements:

1. Provide recessed fixtures with frames appropriate for the type of ceiling mounting.
2. Provide suitable plaster frames where installed in plaster ceilings.
3. Provide fixtures that have wiring, drivers and re-lamping access from below the ceiling unless otherwise indicated.
4. Provide UL listed and labeled enclosure for all fixtures that penetrate rated fire assemblies or that penetrate into unheated areas, such as soffits and attics. Install enclosure, seal all openings with caulking and duct tape and provide plastic cover over enclosure (also caulked and taped) to restrict air infiltration prior to installation of insulation. UL listed enclosure shall be E.Z. Barrier or Tenmat Firedome. If enclosure will not maintain proper clearances around fixture per manufacturer's recommendations, provide sheetrock boxout if allowed by Local Code Authority. Otherwise provide UL listed fixture.
5. LED fixtures shall be UL listed and labeled for thermal protection.

2.5 FIXTURE SCHEDULE

A. General Requirements:

1. Manufacturer's catalog number indicates type, quality, and style, but may not cover driver, ballast, lamp or special details required. The contractor shall provide the lighting fixtures with special features noted.
2. Provide fixtures complete with lamps.
3. Coordinate light fixtures with latest Architectural Reflected Ceiling Plans prior to release of fixture order.
4. Adjust mounting to match ceiling type at no additional cost to Owner.
5. Unless noted otherwise, CRI and color temperatures of lamps shall match. The contractor shall replace pre-installed lamps to match specified building lamps. Refer to Light Fixture Schedule.

B. Acceptable Manufacturers: All lamps shall be:

1. General Electric
2. Osram/Sylvania
3. Phillips

Part 3. - EXECUTION

3.1 INSTALLATION

A. General Requirements:

1. Remove manufacturer's labels from exterior of fixtures.
2. Install fixtures when the work of other trades in the area is substantially complete, to avoid damage or defacement after installation. Fixtures shall not be installed on ceilings until ceiling finishes are complete, except fixtures may be installed on exposed T-bar ceilings after T-bars are installed and before tile installation.
3. Coordinate fixture locations with the ceiling installation and install fixtures in a uniform pattern to tiles or exposed grids. Fixtures shall be symmetrically spaced with rows in alignment and parallel with the building features. Measurements shall be taken from the Architectural Drawings.
4. Install 2x2 fixtures and compact fluorescent downlights with lamps perpendicular to corridor.
5. Where floodlighting has been indicated, provide for adjusting during evening hours to Engineer’s satisfaction.
6. Directional fixtures shall be properly aimed and aligned as directed by the Owner's representative.
7. Provide concrete bases for anchor bolt mounting of all exterior pole mounted fixtures. Refer to the Drawings for base detail.

3.2 FIXTURE MOUNTING

A. General Requirements:

1. Surface fixtures, other than fluorescent type, shall be securely fastened to outlet box.
2. Recessed fixtures, except those installed within an exposed grid type ceiling, shall be supported from building structural members or from concealed steel framing channels 1-1/2 inches or larger. No recessed fixtures shall be supported from ceiling tiles.
3. Individually mounted fluorescent fixtures shall be supported within 12 inches of each end of fixture.
4. Continuous row fluorescent fixtures shall be supported within 12 inches of end of each row and at intervals not to exceed 48 inches along entire row.
5. Chain-hung fixtures shall be permitted only where specifically noted. Chains shall be spaced the same as supports described under this Section. Chains shall be heavy duty, nickel or cadmium plated, suitable for weight of specific fixture. Jack chain shall not be used. Unless otherwise indicated, chain hung fixtures shall be provided with a grounded receptacle and grounded portable cords and plugs to feed individual units or continuous rows. Chain-hung fixtures shall be located on site to clear mechanical ducts and equipment.

3.3 SUPPORTS AND FASTENING

A. For Fixtures Not in Exposed T-Bar Grid Ceilings: Fixture supports, or outlet boxes used to support fixtures, shall be securely fastened to building structural members or to concealed steel ceiling framing channels 1-1/2 inches or larger. Fixture hanging rods shall be of adequate dimensions to support fixture and shall be not less than 3/8-inch diameter. Fixture supports shall be fastened to structure as follows:

1. To concrete with steel or lead expandable concrete anchors set into a minimum of 1-1/2 inches of concrete or with 3/8-inch minimum diameter toggle bolts through concrete.
2. To wood with lag screws a minimum 1/4-inch diameter entering wood structural members a minimum of 2 inches.
3. To 16-gauge steel channels where used to span building bar joists, structural members or ceiling 1-1/2 inch minimum framing channels. Provide Steel City, No. 6029 steel channels or Thomas & Betts.

B. For Fixtures in Exposed T-Bar Grid Ceilings: Fixtures shall be supported as follows:
   1. Recessed fixtures designed expressly for lay-in mounting and under 50 lbs. shall be installed in that manner. Grid system shall be supported from structure by ceiling system installer.
   2. Recessed fixtures not designed for lay-in mounting or over 50 lbs. shall be installed per the manufacturer's requirements. The contractor shall provide all the mounting hardware required. Contractor shall also coordinate with the ceiling system installer and the Architect.
   3. Provide flexible metal conduit connections for all recessed type fixtures in lay-in ceilings permitting fixture to be lifted out. Maximum flexible conduit shall not exceed six feet. One to four fixtures may be served by a single common outlet box, securely fastened to structure or ceiling support members and within 30 inches of ceiling tile.
   4. Provide fixture retainers or clips for each fixture installed in exposed grid suspended ceilings in accordance with UBC and state building codes.
   5. Recessed fixtures, not designed to lay-in directly on grids, shall be centered on ceiling tiles and shall be supported with 16 gauge steel channels used to span over T-bar grids. No fixture shall be supported by ceiling tiles.
   6. Surface mounted fixtures to be centered directly on a T-bar grid shall be secured to that grid with hanger clamps, clips or other approved fasteners designed for the purpose. Unless otherwise noted, ceiling T-bar grid system shall be supported from structure by ceiling system installer.
   7. Surface mounted fixtures to be centered between T-bar grids shall be secured to a 16-gauge steel channel installed by this Contractor to span over top of main T-bar grids. Steel channels shall be Steel City, No. 6029, or Thomas & Betts. Non-main T-bar grids shall not be used to support steel channels. Unless otherwise noted, ceiling T-bar grid system shall be supported from structure by ceiling system installer.

3.4 SPECIAL FIXTURE COORDINATION

A. Storage and Mechanical/Electrical Rooms: Contractor shall verify actual fixture locations with Architect. Fixture locations shall be revised to clear all equipment, ducts, and piping.

END OF SECTION 26 51 00

SECTION 26 51 10
LIGHTING REBATES

Part 1. – GENERAL

1.1 SUMMARY

A. Section Includes: Provide one copy of quantity invoices required by the local power company to allow Owner to receive Energy Rebates for the use of energy saving ballasts and/or energy saving lamps.

Part 2. – PRODUCTS

N/A

Part 3. – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Contractor shall complete and submit all form/applications required by the Utility Company or Energy/Environmental Firm(s).

B. All rebates shall be made directly to Owner.

END OF SECTION 26 51 10